Control Number
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REV -

# USER MANUAL

for

# MODEL D1000

# DUAL PRE-AMP

First Edition
March, 1985

MP MASTER
MA28759

DATA PRECISION, a Division of ANALOGIC Corporation
Electronics Avenue, Danvers, Massachusetts 01923

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SECTION 1

INTRODUCTION

## 1.1 GENERAL DESCRIPTION

The D1000 DUAL PRE-AMP (Figure 1-1) is a pre-amplifier that extends the voltage measuring range of the Model 620 Plug-in Module for the Data 6000, Universal Waveform Analyzer. You would in fact, use the D1000 as if it were part of the 620. Also, the D1000 can be used as a pre-amplifier for any voltage measuring device that requires the same performance characteristics listed in Table 1-1.

The D1000 extends the voltage-measuring range of the 620 from +/- 0.05V (full scale) to +/- 20V (full scale) in a 5-10-20 sequence as follows:

.05V
.1V
.2V
.5V
1.0V
2.0V
5.0V
10.0V
20.0V

The D1000 also allows you to select the input coupling: ac or dc.

The D1000 has two, independent channels that allow you to measure two voltage sources without interaction between them. The full scale, output voltage of each channel is a nominal +/-1V (+/-1.2V max.) for each input range. The D1000 conditions input signals for measurement by the D6000 (or another measuring device). All input and output signals are floating with respect to the chassis.

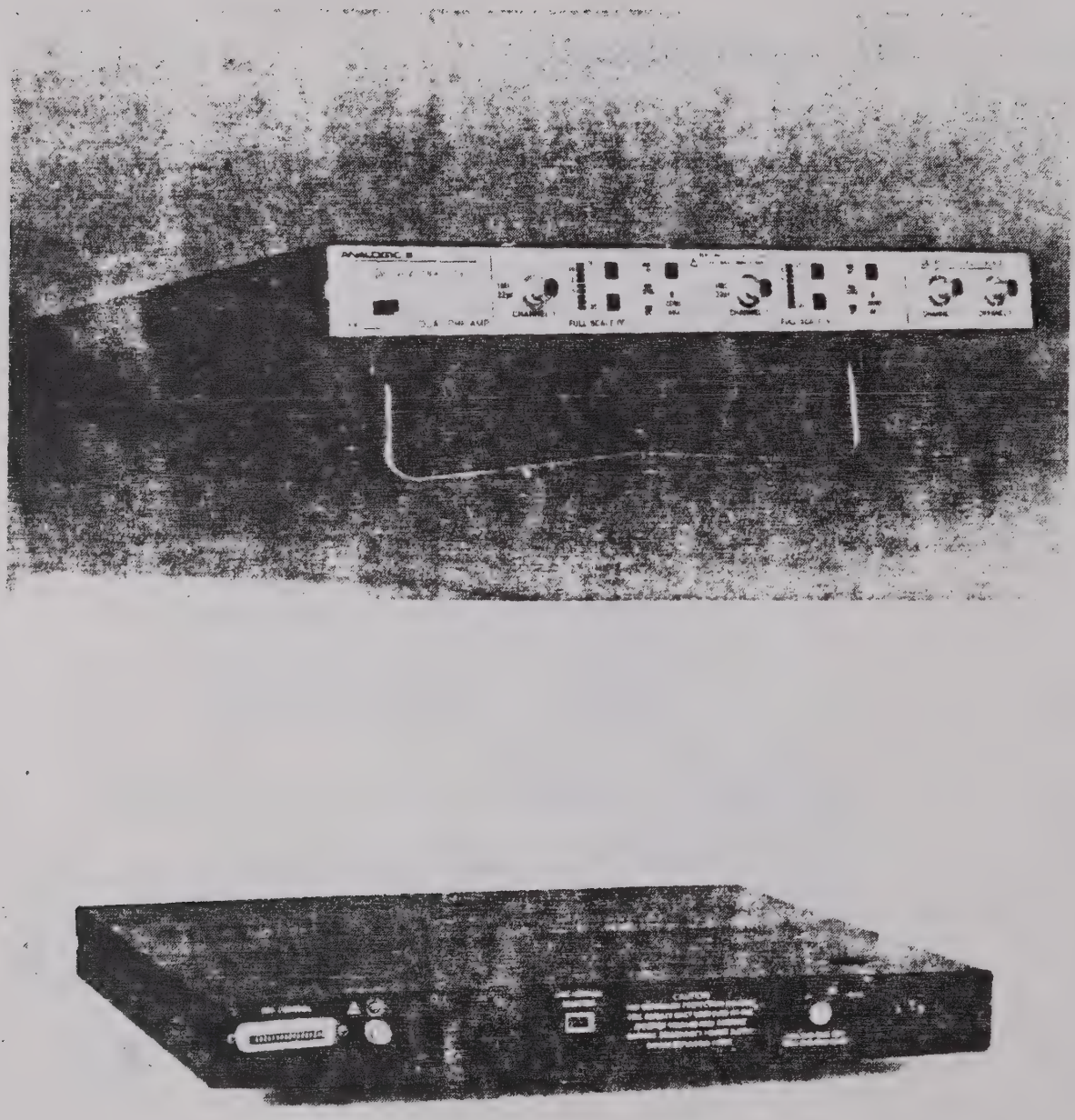


FIGURE 1-1. D1000 DUAL PRE-AMP

DATA 6000
Universal Waveform Analyzer

AMASCO AMASCO AMASCO

FOR ORDERING AND TECHNICAL ASSISTANCE
451 E. Carson Plaza Dr. • Suite 106
Carson • CA 90746
Tel. (213) 516-8561
(619) 565-9676

# D-1000

# Dual Channel, Wide-Band, Low-Noise Preamplifier

## DESCRIPTION

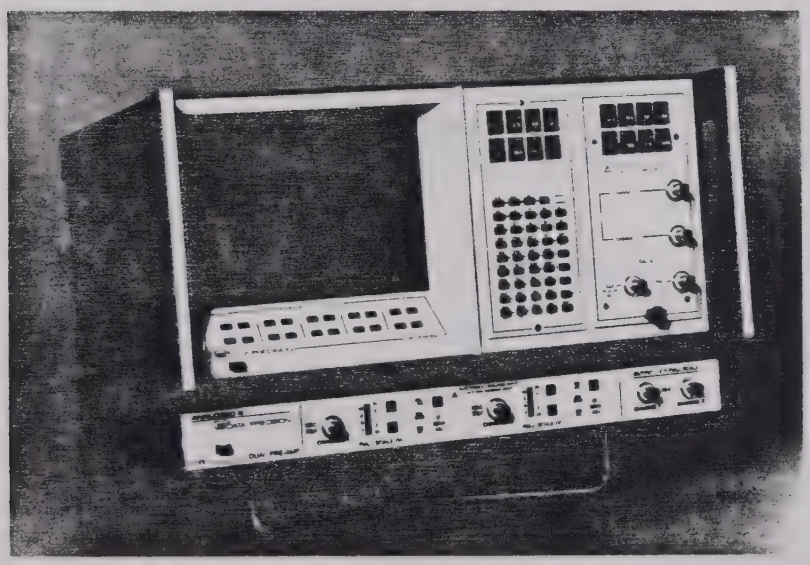
The D-1000 Dual Channel, Wide-Band, Low-Noise Preamplifier was designed to further enhance the performance of the DATA 6000 Waveform Analyzer's Model 620 High Speed 100-MHz Digitizer. Resolution of 400 $\mu$V can now be achieved over the full power bandwidth of the 620 plug-in. In demanding applications requiring high sensitivity and extreme flexibility, the D-1000 offers nine sensitivity ranges from $\pm$50 mV to $\pm$20V as well as ac, dc, or ground coupling on each of the two independent channels.

When used with the DATA 6000 Universal Waveform Analyzer, the D-1000 offers an additional benefit — remote control operation. All range and coupling settings can be controlled and programmed through the DATA 6000 from its front panel, from programs stored on disk, or from a system host via the RS-232 or IEEE 488 communications options.

The D-1000 with its individually isolated and shielded gain stages offers excellent signal accuracy and stability while exhibiting superior low noise and low distortion characteristics. In addition, the D-1000 preamplifier is highly immune to external EMI and RFI.

## FEATURES:

- Two independent floating isolated inputs.
- Wide full-power bandwidth — dc to 35 MHz.
- Fast rise and settling times.
- Nine sensitivity ranges — $\pm$50 mV to $\pm$20V.
- Maximum Nonlinearity — 0.05%
- Low noise and low distortion.
- Stable over full operating temperature range.
- Standard EIA rack mount available.
- Operates from 115V or 230V power.



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DATA PRECISION

Data Precision ■ 16 Electronics Ave. ■ Danvers, MA 01923 ■ (617) 246-1600 ■ Toll Free: 1-800-343-8150
■ Telex: 921819 or 6817144

D-1000

# SPECIFICATIONS

## PERFORMANCE CHARACTERISTICS

| | |
|---|---|
| **Number of Channels:** | 2 independent |
| **Input Isolation:** | Floating |
| **Common Mode Rejection:** | >80 dB |
| **Input Full Scale Ranges:** | ±0.05V, ±0.1V, ±0.2V, ±0.5V, ±1V, ±2V, ±5V, ±10V, ±20V |
| **Maximum Safe Input Voltage:** | 120V rms, indefinitely |
| **Input Impedance Each Channel:** | 1 Megohm, 22 pF |
| **Input Coupling:** | DC, AC, GND (AC time constant = 22 ms) |
| **Full Power Bandwidth:** | DC to 35 MHz |
| **Frequency Response:** | 35 MHz @ −3 dB |
| **Nominal Full Scale Output:** | ±1.0V |
| **Maximum Full Scale Output (20% Headroom):** | ±1.2V |
| **Output Impedance:** | 50 ohms |
| **Long Term Gain Stability (6 months, 23°C ± 5°C):** | ±0.2% |
| **Long Term Offset Drift (6 months, 23°C ±5°C):** | ±0.2% Range |
| **Noise (Ref. to Full Scale Output):** | ≥ −80 dB (500 mV to 20V ranges), ≥ −73 dB (100 mV & 200 mV ranges), ≥ −67 dB (50 mV range) |
| **Temperature Coefficient:** | ±(0.025% input + 0.025% range)/°C. Referred to the input. |
| **Zero Offset Adjust:** | Front Panel Adjustable. (Auto nulled when used with D-6000) |
| **Transient Response:** | |
| **Rise Time:** | Less than 10 ns |
| **Overshoot:** | 1% maximum |
| **Settling Time:** | 30 ns maximum to 0.1% |
| **Maximum Output Slew Rate:** | No slew rate limitation over specified bandwidth. |
| **Interchannel Modulation:** | 0.05% maximum |
| **Total Harmonic Distortion (1 MHz):** | 0.05% maximum |
| **Nonlinearity:** | 0.05% maximum |

## POWER REQUIREMENTS

| | |
|---|---|
| **Input Power:** | 90 to 130 Vac<br>180 to 260 Vac |
| **Line Frequency:** | 48 to 62 Hz |
| **Power Consumption:** | 12W (approximately) |

## PHYSICAL/ENVIRONMENTAL

| | |
|---|---|
| **Width:** | 16.88" (42.88 cm) (19" rack-mountable with rack mount option) |
| **Height:** | 1.72" (4.37 cm) without feet,<br>2.32" (5.90 cm) with feet |
| **Depth:** | 15.42" (39.20 cm) |
| **Weight:** | 11 lbs (5 kg) |
| **Operating Temperature:** | 10°C to 35°C |



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TABLE 1-1. SPECIFICATIONS FOR D1000 DUAL PRE-AMP

Performance Characteristics

| | |
|---|---|
| Number of Channels: | 2 independent |
| Input Isolation: | Floating |
| Input Full Scale Ranges: | +/- 0.05V to +/- 20V in a 5-10-20 sequence as follows:<br>.05V<br>.1V<br>.2V<br>.5V<br>1.V<br>2.V<br>5.V<br>10.V<br>20.V |
| Maximum Safe Input Voltage: | 120V rms, indefinitely |
| Input Impedance Each Channel: | 1 Megohm, 30 pF |
| Input Coupling: | DC, AC, GND (AC time constant = 22 msec.) |
| ~~Power Bandwidth:~~ | ~~DC to 29MHz~~ |
| Frequency Response | 29Mhz @ -3dB |
| Nominal Full Scale Output: | +/- 1.0V |
| Maximum Full Scale Output | +/- 1.2V |
| Output Impedance: | 50 ohms |

TABLE 1-1. SPECIFICATIONS FOR D1000 DUAL PRE-AMP (cont'd.)

| | |
|---|---|
| Long Term Gain Stability (6 mos., 23°C +/- 5°C): | +/- 0.2% |
| Noise (ref. to Full Scale Output): | -60dB (20V - .5V range)<br>-40dB (.2V - .05V ranges) |
| Zero Offset Adjust: | Front panel adjustable. (Auto nulled when used with D6000). |
| Transient Response: | |
| Rise Time: | Less than 12nsec. |
| Overshoot: | 5% max. |
| Settling Time: | 50nsec. max. to 0.1% |
| Maximum Output Slew Rate: | No slew rate limitation over specified bandwidth |
| Interchannel Modulation: | 0.05% max. |
| Total Harmonic Distortion (1Mhz): | 0.05% |

Power Requirements

| | |
|---|---|
| Input Power: | 90 to 130 VAC<br>180 to 260 VAC |
| Line Frequency: | 48 to 62Hz |
| Power Consumption: | 30 watts (approx.) |

TABLE 1-1. SPECIFICATIONS FOR D1000 DUAL PRE-AMP (cont'd)

| | |
|---|---|
| **Environmental Characteristics** | |
| Operating Temperature: | 10° - 35° C |
| Humidity: | Up to 80% (non-condensing) |
| Altitude: | Up to 15,000 ft. (temperature derated 1° C/1000 ft. above 5000 ft.) |
| **Physical Dimensions** | |
| Width: | 16.88 in. (42.88cm) (19-in. rack mountable) |
| Height: | 1.72 in. (4.37cm) without feet<br>2.32 in (5.90cm) with feet |
| Depth: | 15.42 in. (39.20cm) |
| Weight: | 11 lbs. |

## 1.2 FEATURES OF D1000

The D1000 has a number of features that are advantageous to you. Some of them are:

- Power bandwidth of DC to 35MHz
- Low distortion
- Low noise
- Floating inputs and outputs
- Maximum safe input voltage of 120V rms indefinitely
- Two independent amplification channels

## 1.3 HOW TO USE THE D1000

The D1000 is easy to use. First, you must mount it in either a standard 19-inch rack or on a work bench. This is an option available to you. See paragraph 1.5.2 for details.

You connect all cables for voltage measurement to BNC connectors located on the front of the D1000.

A power connector is located on the rear of the D1000. As an option, you can connect your DUAL PRE-AMP to either a 117 VAC or a 230 VAC source. (See paragraph 1.5.1 for details.)

Next, you select the channel or channels you want, and connect a coaxial cable from the voltage source to the CHANNEL 1 or 2 BNC input connector. Then you connect a second coaxial cable from the OUTPUT CHANNEL 1 or 2 BNC connector to the input of the 620, o the voltage measuring device you are using.

Then you press pushbuttons on the front of the D1000 to select both the full scale range and input coupling you want. You then measure the voltage on the D6000 (or your measuring device). Detailed operating instructions are available in Section 3 of this manual.

## 1.4 50-OHM TERMINATOR BOX

You receive a 50-ohm Terminator Box (Figure 1-2) with your D1000 DUAL PRE-AMP. This box contains a 50-ohm precision (0.01%), 1/4 watt resistor.

The resistor is a terminating resistor that matches the 50-ohm characteristic impedance of a coaxial cable. This cable applies the output of the D1000 to the MODEL 620 Plug-in Module in the D6000. Without this resistor, the voltage readings you would see on the D6000 would be about twice their expected value. Hence, without this terminator box, all your voltage measurements would be erroneous. Therefore, you must use the terminator box for all your voltage measurements.

There are BNC connectors on each end of the box. You connect the coaxial cable to the 'IN' connector on the box, and you connect the 'OUT' connector to the 620. You will find detailed installation instructions in Section 2 of this manual.

When using the terminator box, remember that the resistor within the box is rated at 1/4 watt. Therefore, do not apply a voltage to the resistor that will burn it out.

## 1.5 OPTIONS

There are a number of options that are available to you. They are described in paragraphs 1.5.1 thru 1.5.4 that follow.

### 1.5.1 Dual Line Voltage of 117 or 230 VAC -

You can use a line voltage of either 115 VAC or a 230 VAC. The D1000 provides you with a LINE VOLTAGE SELECTOR switch on the rear side of the D1000. Use it to select the desired voltage.

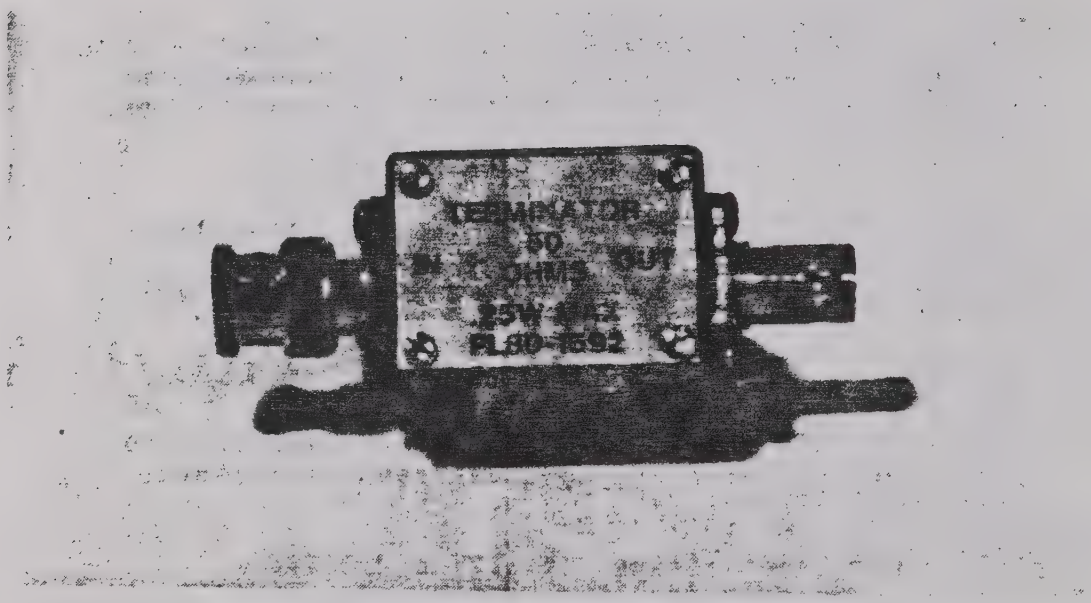



FIGURE 1-2. 50-OHM TERMINATOR BOX

### 1.5.2 Rack Mounting or Standalone Configuration

You can either mount the D1000 in a standard 19-inch rack, or you can mount it in a standalone configuration on a work bench. The D1000 comes equipped with a collapsible stand and rubber feet which allow you to set it up on a work bench. If you want to mount your D1000 in a rack, you must first remove the stand and rubber feet. You will find detailed mounting instructions in Section 2 of this manual.

### 1.5.3 External Control -

The D1000 has a connector on its rear side labelled EXT. CONTROL. This connector allows you to plug a cable between the D1000 and an EXT. CONTROL connector on the rear of the D6000. This cable, plus additional PROM's plugged into the MODEL 620 Plug-in Module allow you to select both the full scale range and input coupling from the keyboard of the D6000. (See Appendix A for details.)

If you desire this option, contact your sales representative, or contact Data Precision directly using the address and phone number on the back of this manual.

### 1.5.4 Removing Floating Input and Output -

If you are using the D6000 as your voltage measuring device, you may find, after a period of time, that you are having a problem with noise when trying to measure voltages less than .5V. If you have this problem, you can, at your option, short the floating ground to chassis (earth) ground of the D1000. This removes the floating input and output feature of the D1000. See para. 2.3.5 in Section 2 and Appendix B for details.

SECTION 2

INSTALLATION

## 2.1 INTRODUCTION

This section provides instructions for installing the D1000 DUAL PRE-AMP. It presents the following topics:

- o Unpacking procedures including
  - Equipment supplied
  - Equipment not supplied
- o Installation procedures
  - Rack mounting procedures
  - Standalone procedures
  - Terminator mounting procedures
- o Connecting power
  - Selecting proper line voltage
  - Connecting line cord
- o External control option

## 2.2 UNPACKING PROCEDURES

By the time you reach this section you will have already:

1. Opened the shipping carton.
2. Removed the contents.

Next you should perform the procedures outlined in paragraph 2.2.1 that follows.

### 2.2.1 Equipment Supplied -

You should have the following items within the shipping carton.

1. One poly bag containing the D1000 DUAL PRE-AMP.

2. One poly bag containing the following:

   a. One Warranty Card

   b. One Certificate of Conformance

   c. One Test Data Sheet

   d. One Instruction Manual (this manual)

3. One poly bag containing the following:

   a. Two 50-ohm terminator boxes

   b. Two male, BNC, 12-in.coaxial cables

4. One zip bag containing the rack mount kit.

5. One line cord.

Examine the contents of the shipping carton for physical damage. If any is detected, file a claim with the carrier immediately.

Fill out the Warranty Card. If possible, this should be done by the specifying engineer. Receipt of this card by Data Precision Division of Analogic Corporation registers your instrument for the Warranty period of one year. Until you file the Warranty Card with Data Precision, your D1000 DUAL PRE-AMP is not covered by the warranty.

Next, examine your Certificate of Conformance. Notice that it is filled out completely. File it along with the Test Data Sheet for future reference.

### 2.2.2 Equipment Not Supplied -

In addition to the equipment you are supplied, you will need the following:

1. Up to two coaxial cables to connect the D1000 DUAL PRE-AMP to the signal source.

2. One coaxial cable, which functions as a ground strap, to connect a BNC connector (identified by a ground symbol ⏚ ) on the rear of the D1000 with an unused input BNC connector on the rear of the D6000. This cable should be as short as possible.

## 2.3 INSTALLATION PROCEDURES

The D1000 DUAL PRE-AMP can be mounted either in a standard 19-inch NEMA rack or as a standalone module on a test bench.

- If you want to mount your D1000 in a rack go to para. 2.3.1.
- If you want to mount your D1000 as a standalone module go to para. 2.3.2.
- Regardless of which mounting method you use, you must mount the 50-ohm terminator box on the 620 Plug-in Module (see para. 2.3.3).
- You must connect the ground cable between the D1000 and the D6000. (You may have to connect a ground strap between the D1000 and another voltage measuring device too). See para. 2.3.4.

### 2.3.1 Rack Mounting Procedures -

1. Remove the plastic bag from your D1000.
2. Remove the 12-inch bail stand and two rubber feet from the bottom of the PRE-AMP housing (see Figure 2-1).
3. Open the zip bag containing the rack mounting kit.

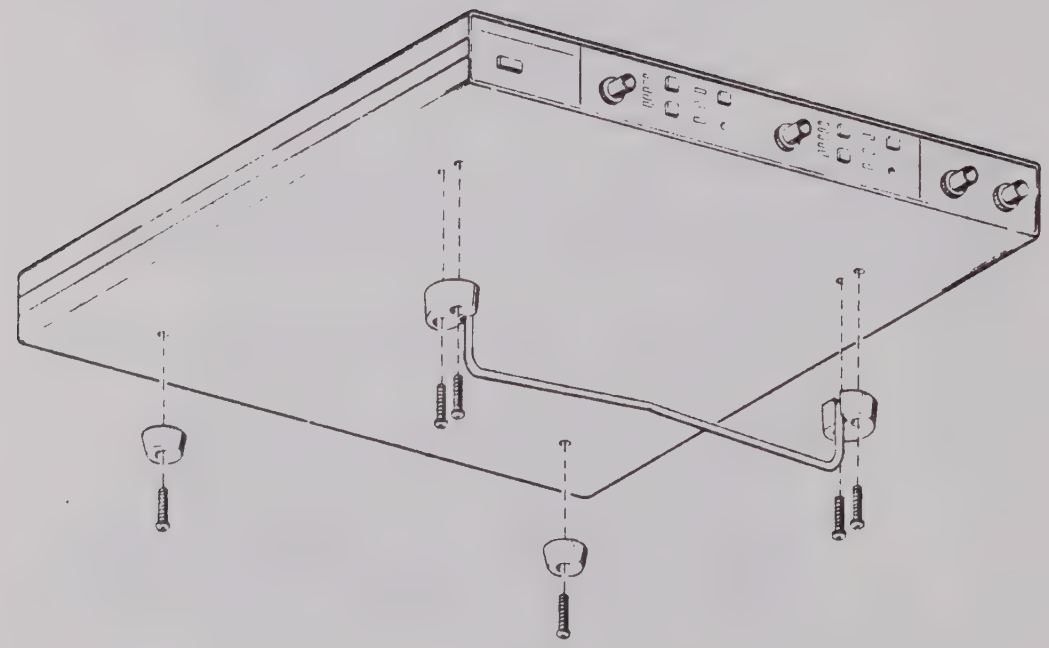


FIGURE 2-1. REMOVING 12-INCH BAIL STAND AND RUBBER FEET FROM BOTTOM OF PRE-AMP

4. Using the rack mount installation drawing within the kit, fasten two mounting brackets (ears) to the sides of the D1000 DUAL PRE-AMP.

NOTE

Normally, you would mount the D1000 in the 19-inch rack immediately below the DATA 6000 (see Figure 2-2). If you cannot do this, then mount the DUAL PRE-AMP as close to the D6000 as possible.

5. Fasten the D1000 to the rack with four button screws (see Figure 2-3).

6. You have now rack mounted the D1000.

7. Next go to para. 2.3.3 and install the 50-ohm terminator box on the 620.

### 2.3.2 Standalone Procedures -

1. Remove the plastic bag from the D1000.

2. Extend the 12-inch bail to the standing position for the DUAL PRE-AMP (see Figure 2-4).

3. Select a location convenient to both the source you wish to measure and the measuring device.

NOTE

The D1000 has indents in its top cover for the D6000 to sit in.

4. You have now mounted your D1000 in the standalone configuration.

5. Next go to paragraph 2.3.3 and install the 50-ohm terminator on the 620.

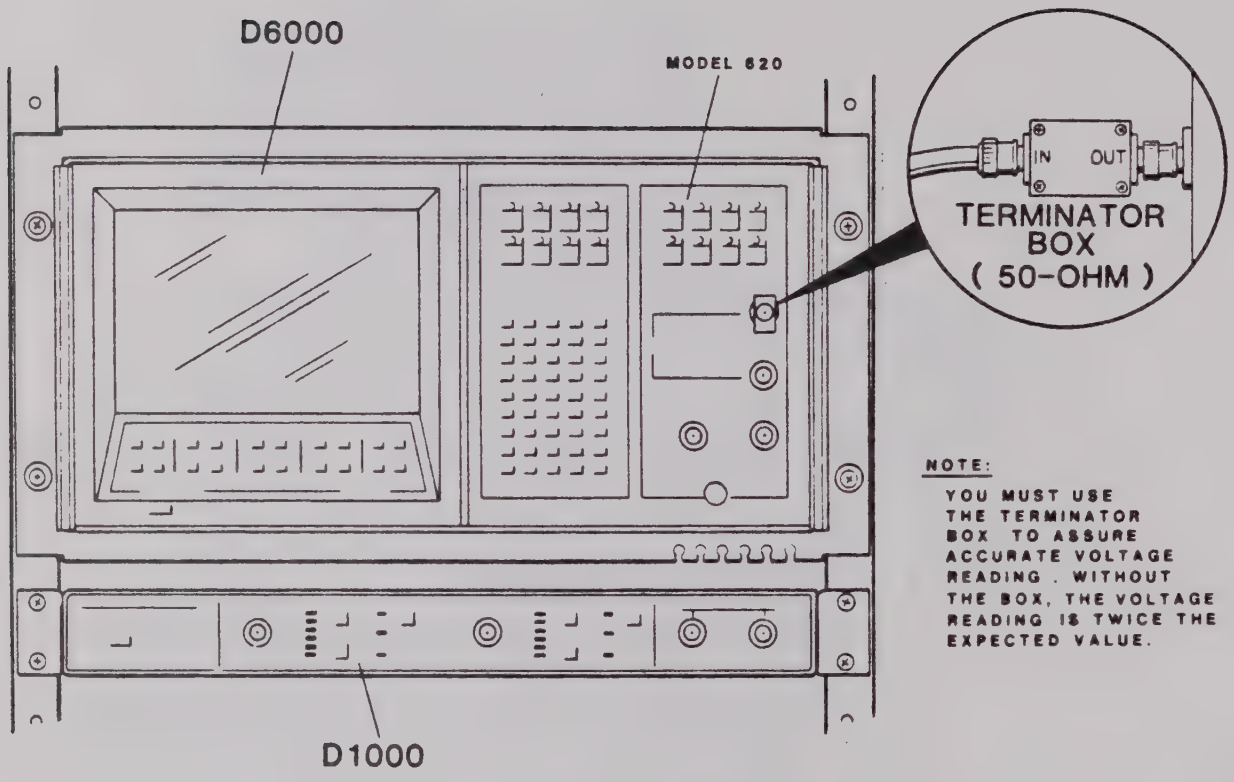



FIGURE 2-2. D1000 DUAL PRE-AMP RACK MOUNTED BELOW D6000

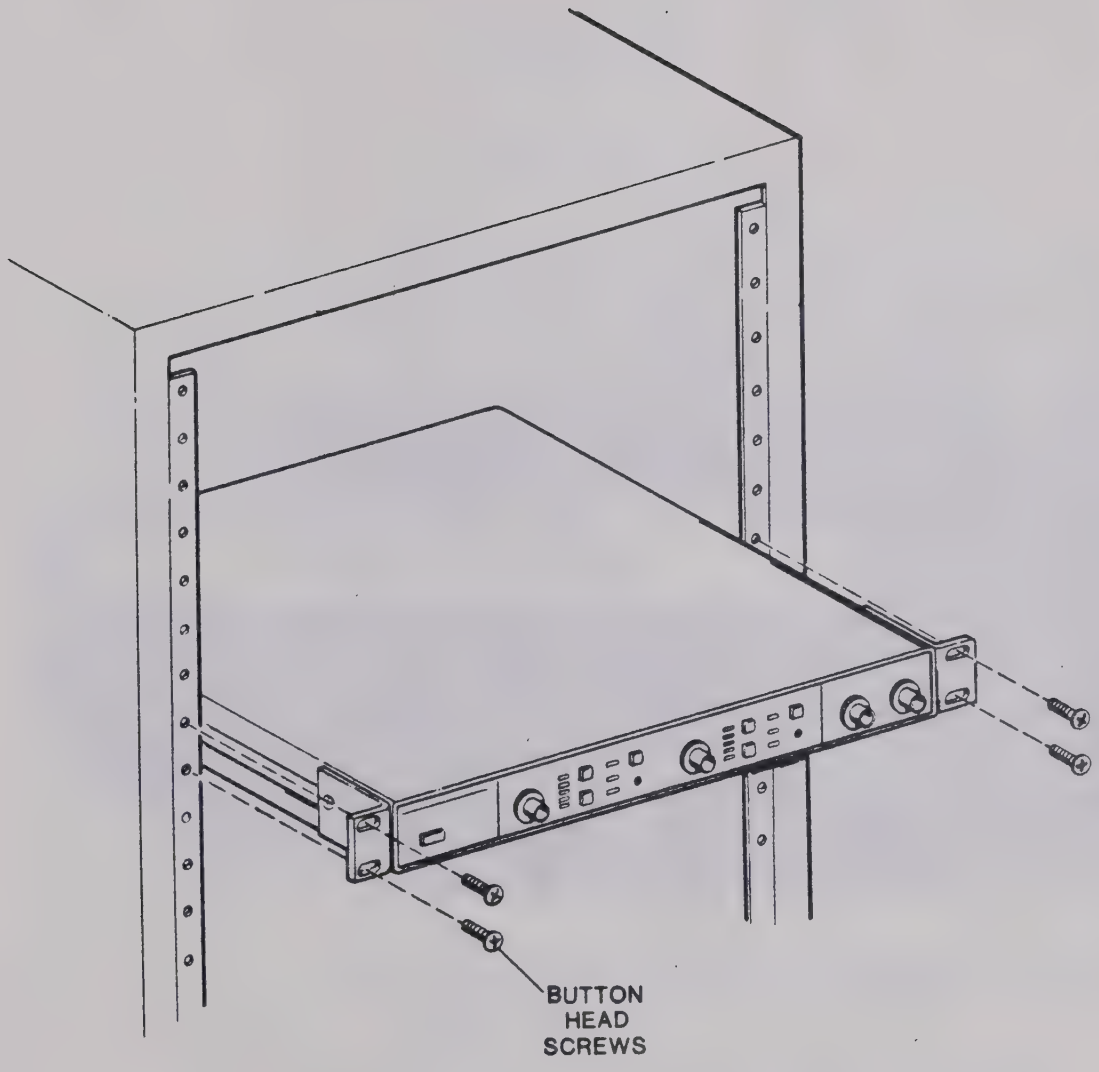



FIGURE 2-3. INSERTING D1000 INTO 19-INCH RACK

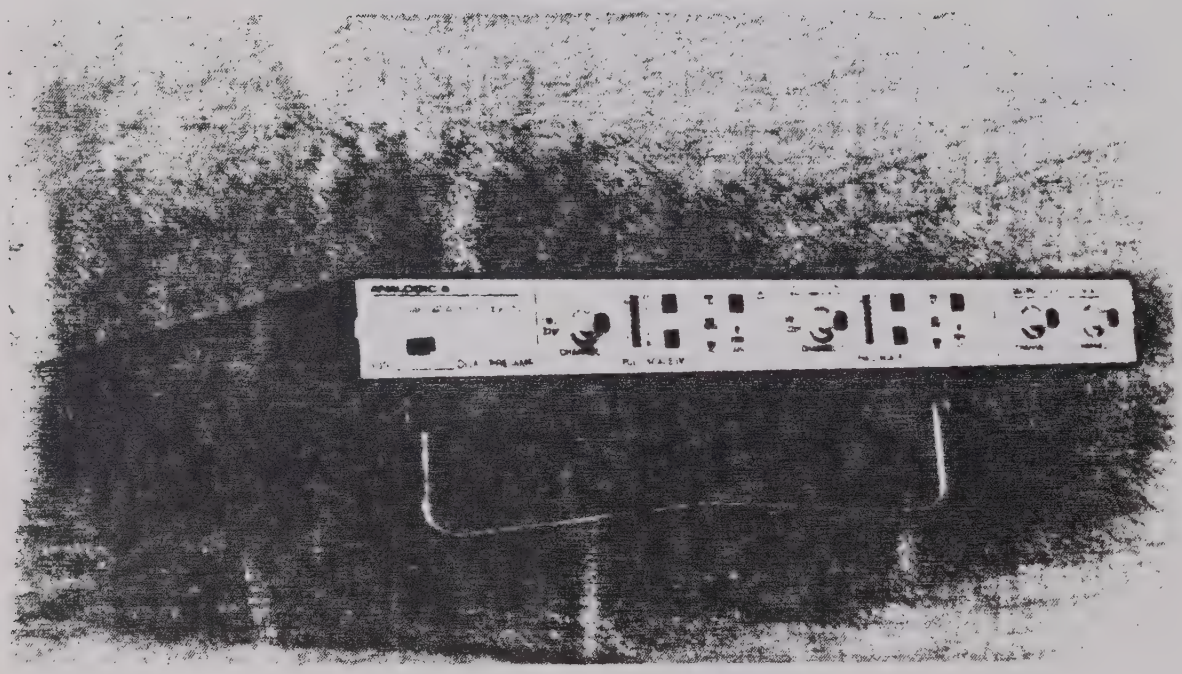


FIGURE 2-4. D1000 DUAL PRE-AMP IN STANDALONE CONFIGURATION

### 2.3.3 Terminator Box Mounting Procedures (see Figure 2-2) -

You must use the terminator box to assure accurate voltage measurements.

1. Open the poly bag containing the two terminator boxes and cables, and remove the contents.

2. Connect the cable to the IN connector on the terminator box.

3. Connect the OUT connector to either the CHANNEL 1 or CHANNEL 2 BNC input terminal on the MODEL 620 Plug-in Module. You determine the input you want to use.

### 2.3.4 Grounding D1000 to Voltage Measuring Device -

- If your voltage measuring device is the D6000, go to step 1.

- If your measuring device is not a D6000, go to step 2.

1. If you are using the D6000 as your voltage measuring device, then you must connect a coaxial cable between the BNC connector ( ⏚ ) on the rear of the D1000 and any unused input coaxial connector on the rear of the D6000 (see Figure 2-5). This cable should be as short as possible.

2. If your measuring device is an instrument other than the D6000, you may or may not connect a ground strap between the two instruments.

   a. If you suspect that your voltage measurements will be noisy in the ranges below .5V, connect a ground strap between the D1000 and your instrument. Connect the strap between the outer shell of the BNC connector on the rear of the D1000 and chassis ground on your instrument.

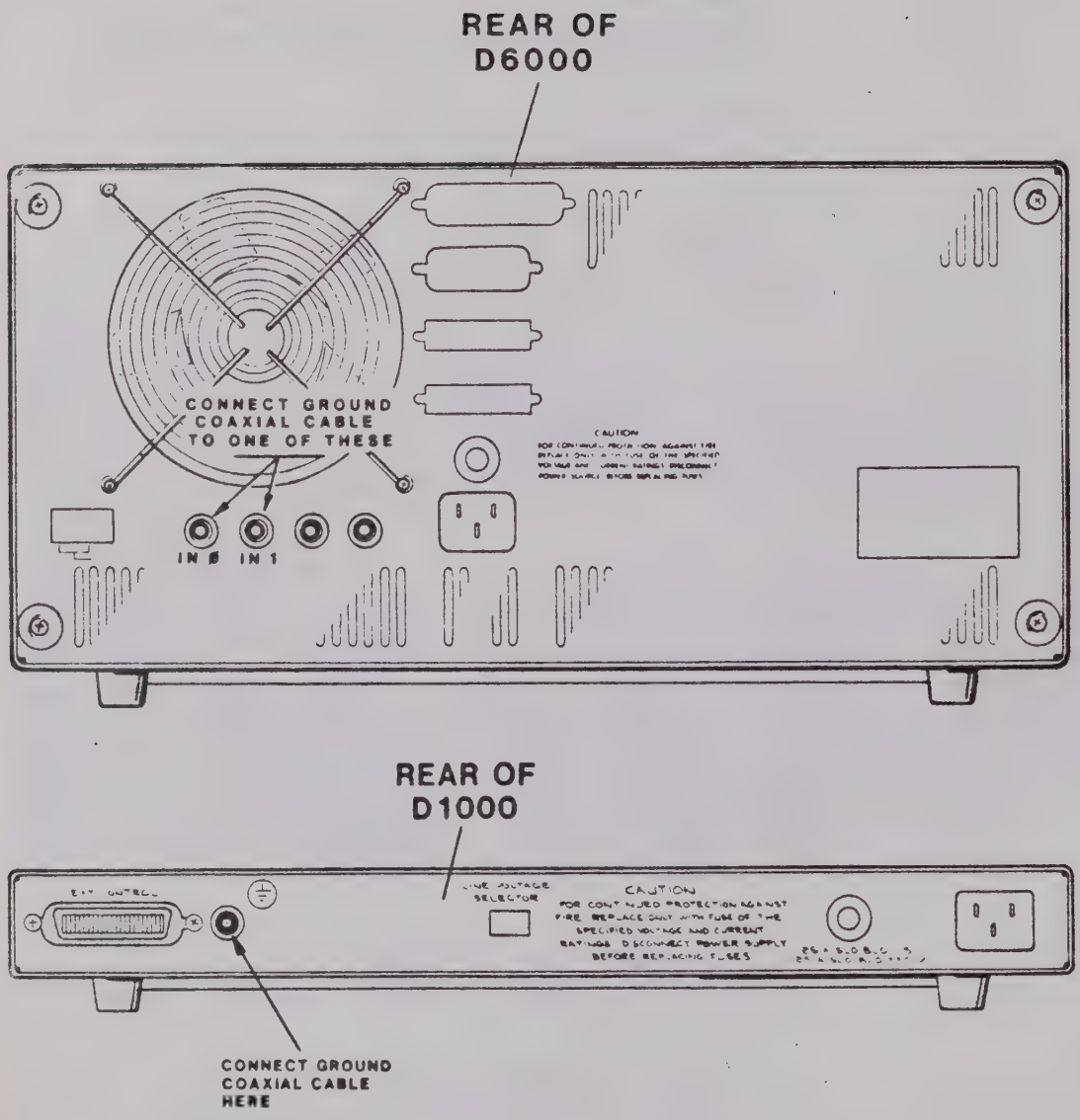



FIGURE 2-5. LOCATION OF BNC CONNECTORS OF D1000 AND D6000 FOR CONNECTION OF GROUND COAXIAL CABLE

NOTE

The outer shell of the BNC connector is mechanically joined to the rear panel of the D1000. This joining action provides the ground connection to the D1000. Thus, make any ground connection to this shell. The inner conductor is also connected to chassis (earth) ground on the D1000.

b. If noise will not be a problem to you, do not connect a ground strap between the two instruments.

### 2.3.5 Shorting Floating Ground to Chassis Ground of D1000 -

Normally the inputs and outputs of the D1000 are floating. However, there may be some applications, particularly when you are measuring voltages less than .5V with the D6000, where your measurements become excessively noisy.

You will have to decide when your measurements are becoming "excessively" noisy. You may not be able to make this decision until after you have been using your D1000 for a period of time. If you decide that the noise level is "excessive", you may want to short your floating ground to chassis ground. Go to Appendix B and perform the instructions cited there to short the floating ground to chassis ground.

## 2.4 CONNECTING POWER

Before connecting the line cord to the main power line feeding the DUAL PRE-AMP, you must know the voltage on that line. It will be either 115 or 230 VAC. The line frequency must be between 47 and 63Hz.

### 2.4.1 Selecting Proper Line Voltage -

Referring to Figure 2-6, set the LINE VOLTAGE SELECTOR switch on the back of the DUAL PRE-AMP to either 115 or 230 as follows:

1. Set the switch to 115 for a line voltage of 115 VAC.

2. Set the switch to 230 for a line voltage of 230 VAC.

CAUTION

Do not set the switch for 115 VAC operation when the line voltage is 230 VAC.

3. Check the fuse (see Figure 2-6). It must be rated for 0.25A for 115 VAC or 0.125A for 230 VAC.

### 2.4.2 Connecting Line Cord -

1. Before connecting the line cord to the D1000, press the ON-NOT-ON switch on the front panel to the NOT ON position.

2. Connect the line cord to the male receptacle on the rear of the DUAL PRE-AMP (see Figure 2-6).

3. Connect the line cord to the main power line.

CAUTION

The main power line socket must accommodate the three-prong male plug of the line cord. If it does not, then you must use a three-prong adapter with a ground wire. You must attach this wire to an earth ground.

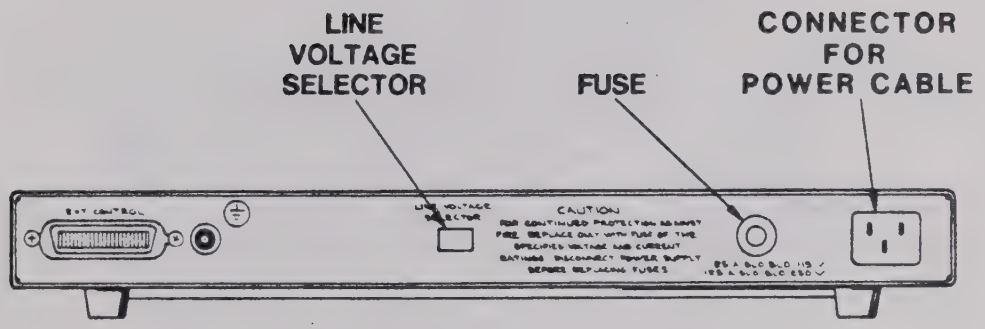



FIGURE 2-6. REAR VIEW OF D1000 DUAL PRE-AMP SHOWING LINE VOLTAGE SELECTOR, SOCKET FOR LINE CORD, AND FUSE

## 2.5 EXTERNAL CONTROL OPTION

The External Control Option allows you to select both the coupling and the voltage ranges of the D1000 PRE-AMP from the keyboard of the D6000.

The External Control Option consists of a cable and PROM's that you must purchase separately from your D1000. This option is available in two forms:

1. The first form consists of a cable. You will need this cable if your MODEL 620 Plug-in Module already contains the External Control Option PROM's. If you need this cable, order it as follows:

   a. External Control Cable, P/N 620/D1000(696A)

2. The second form consists of both the cable and an External Control Conversion Kit, which contains the PROM's that you must plug into the 620. You will need both items if your 620 does not contain the External Control Option. If you do not have this option, then order both items as follows:

   a. The External Control Cable, P/N 620/D1000(696A).

   b. Ext. Control Conversion Kit (696B), P/N 620/D1000(696B).

You can order the External Control Option from your sales representative or from Data Presision using the address information listed on the back of this manual.

### 2.5.1 Installation of External Control Cable, P/N 620/D1000(696A) -

To install this cable do the following:

1. Plug one cable connector into EXT.CONTROL on the back of the D1000 DUAL PRE-AMP (see Figure 2-7).

2. Plug the other cable connector into EXT.CONTROL on the rear of the D6000.

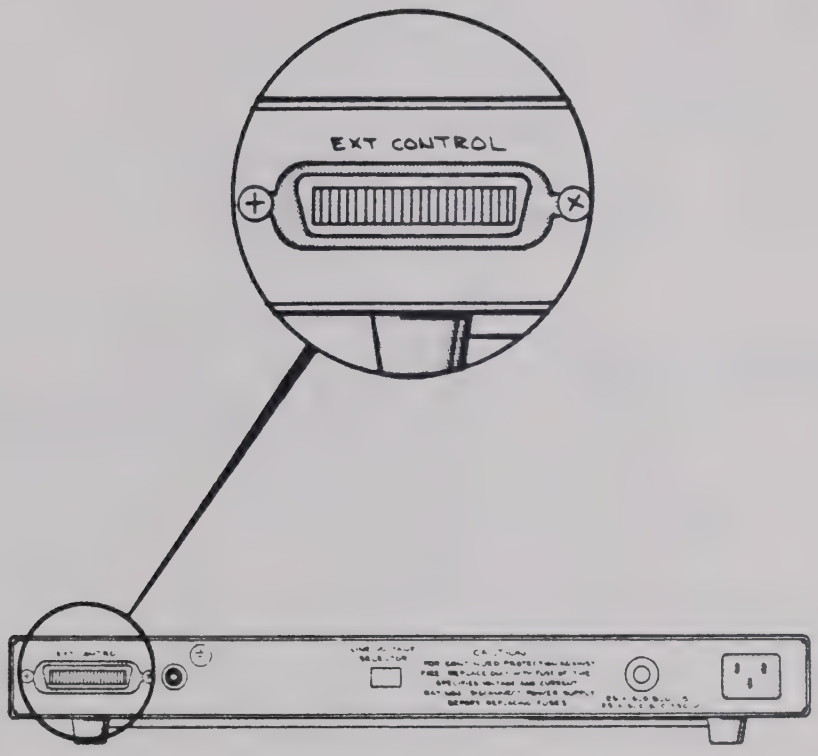



FIGURE 2-7. REAR VIEW OF D1000 DUAL PRE-AMP SHOWING LOCATION OF 'EXT. CONTROL' CONNECTOR

### 2.5.2 Installation of Ext. Control Conversion Kit (620), P/N 620/D1000 -

This kit contains the installation instructions. Follow these instructions to install the kit.

SECTION 3

# OPERATING PROCEDURES

## 3.1 INTRODUCTION

This section provides instructions to operate the D1000 DUAL PRE-AMP. It presents the following topics:

- Description of operating controls
- How to use the D1000 to measure signals from a voltage source
- How to change voltage sources during operation
- How to shut down the D1000

## 3.2 DESCRIPTION OF OPERATING CONTROLS

The operating controls are located on the front panel of the D1000 (See Figure 3-1). Table 3-1 describes the function of each control.

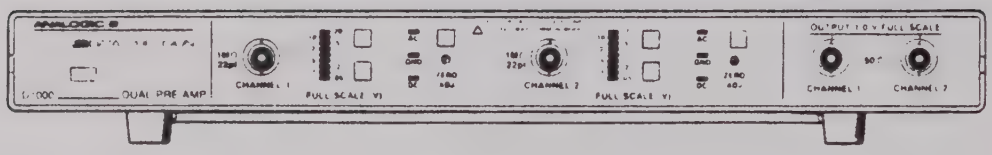



FIGURE 3-1. D1000 DUAL PRE-AMP, FRONT PANEL

TABLE 3-1. DESCRIPTION OF OPERATING CONTROLS

| NAME | FIG. NO. REF. | FUNCTION |
|---|---|---|
| ON-NOT ON Pushbutton Switch | 3-2 | In ON position, switch applies primary power to the D1000. The "20" indicator above FULL SCALE (V) and the "DC" indicator for each Channel turn on. The lighted indicators show that the circuits within the D1000 are receiving the proper operating voltages.<br><br>In NOT ON position, the switch removes primary power from the D1000. All lighted indicators go out. This shows that the D1000 is off. |
| FULL SCALE(V) Pushbutton Switches & Indicator Lights | 3-3 | The pushbuttons select one of the nine FULL SCALE ranges in either ascending or descending order. (The ranges are .05V, .1V, .2V, .5V, 1V, 2V, 5V, 10V, 20V). The lighted indicator shows which range you have selected. Only one range is active at a time.<br><br>The upper pushbutton moves the voltage range from a lower value to a higher value. The lower pushbutton moves the voltage range from a higher value to a lower value. |

TABLE 3-1. DESCRIPTION OF OPERATING CONTROLS (Cont'd.)

| NAME | FIG. NO. REF. | FUNCTION |
|---|---|---|
| AC-GND-DC coupling Pushbutton & Indicators | 3-4 | The pushbutton selects the coupling between the voltage source and the input to the D1000. The lighted indicator shows the selected coupling.<br><br>AC = AC coupling<br><br>GND = ground input to DUAL PRE-AMP. The input to the D1000 is switched from the voltage source to ground.<br><br>DC = DC coupling<br><br>Pressing the pushbutton repeatedly selects the coupling in the following order:<br><br>DC to GND to AC to DC to GND to AC (cycle keeps repeating) |
| ZERO ADJ Screwdriver Adjustable Control | 3-5 | Corrects the DC offset of signal going to D6000. (You will need a small screwdriver to adjust this control). |

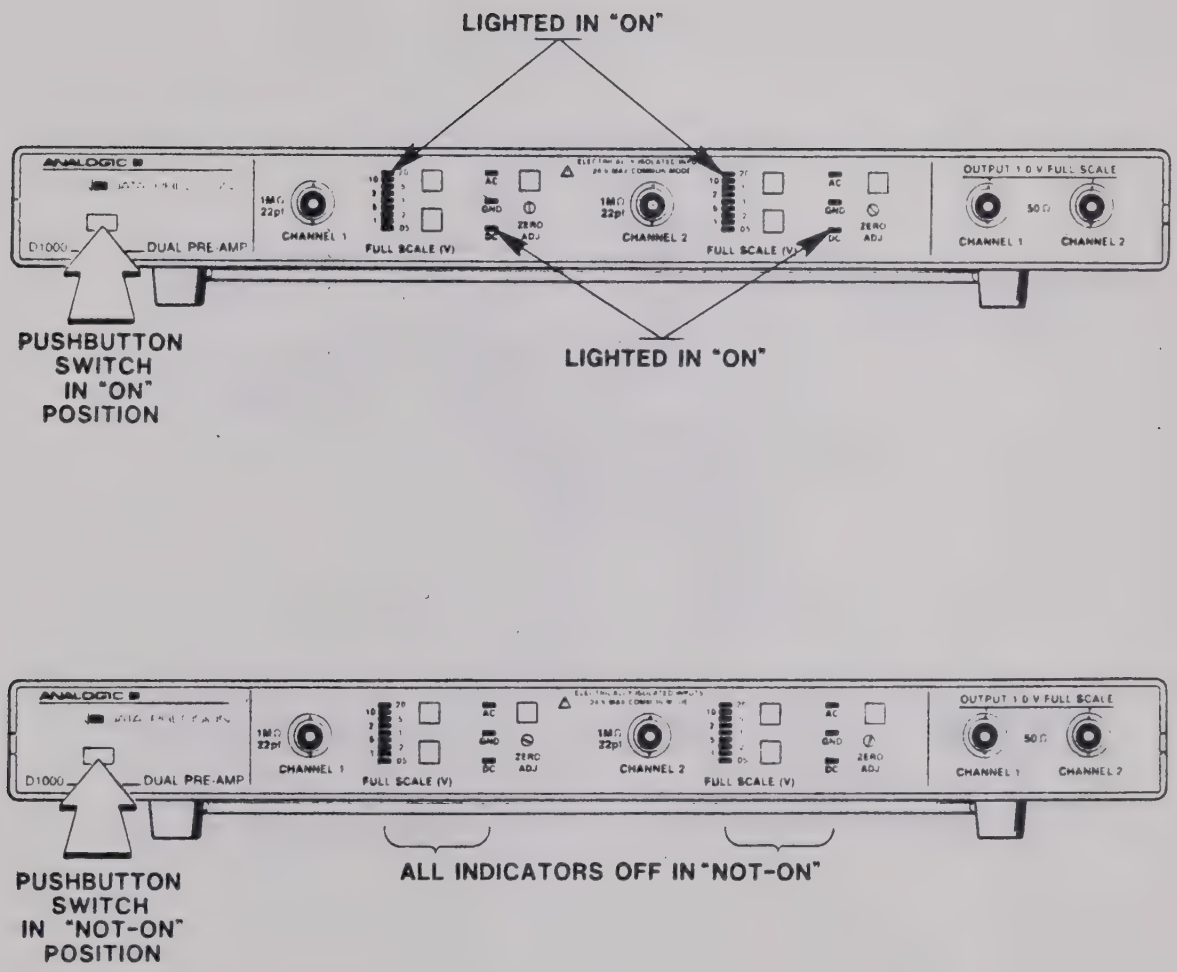



FIGURE 3-2. D1000 DUAL PRE-AMP, ON - NOT ON SWITCH

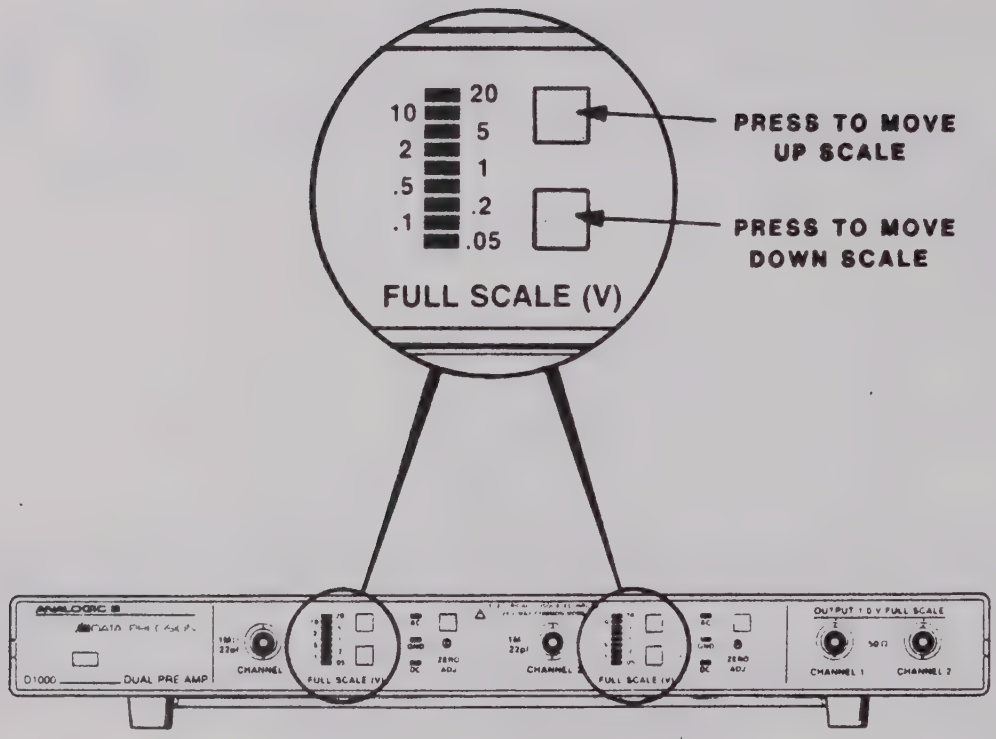



FIGURE 3-3. D1000 DUAL PRE-AMP, FULL SCALE (V) PUSHBUTTONS AND INDICATORS

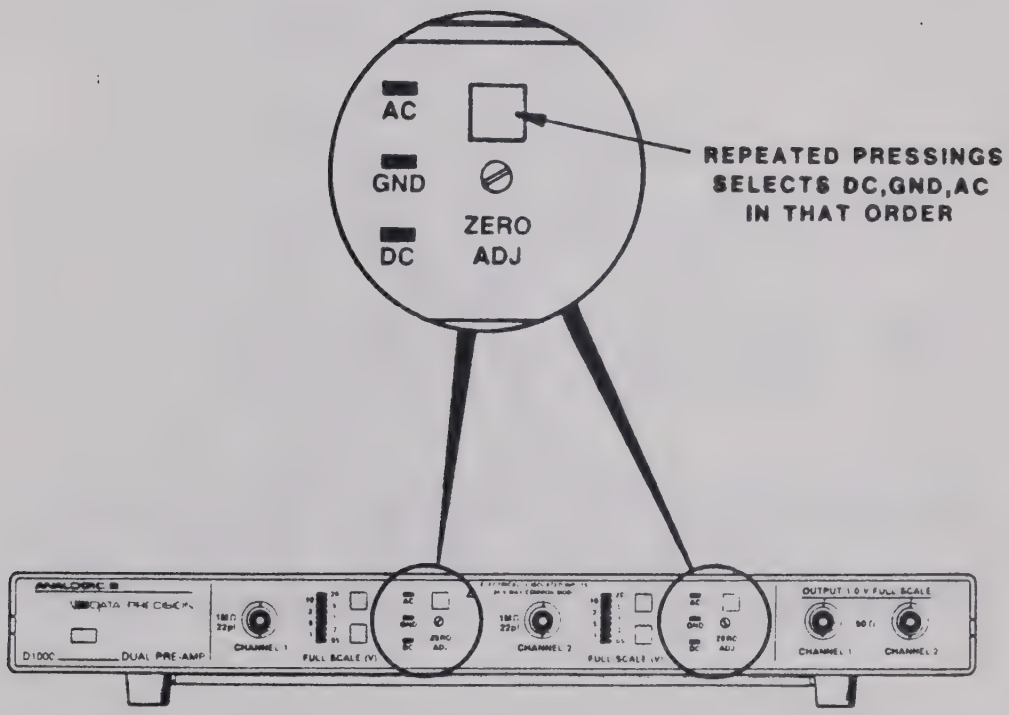



FIGURE 3-4. D1000 DUAL PRE-AMP, COUPLING CONTROLS

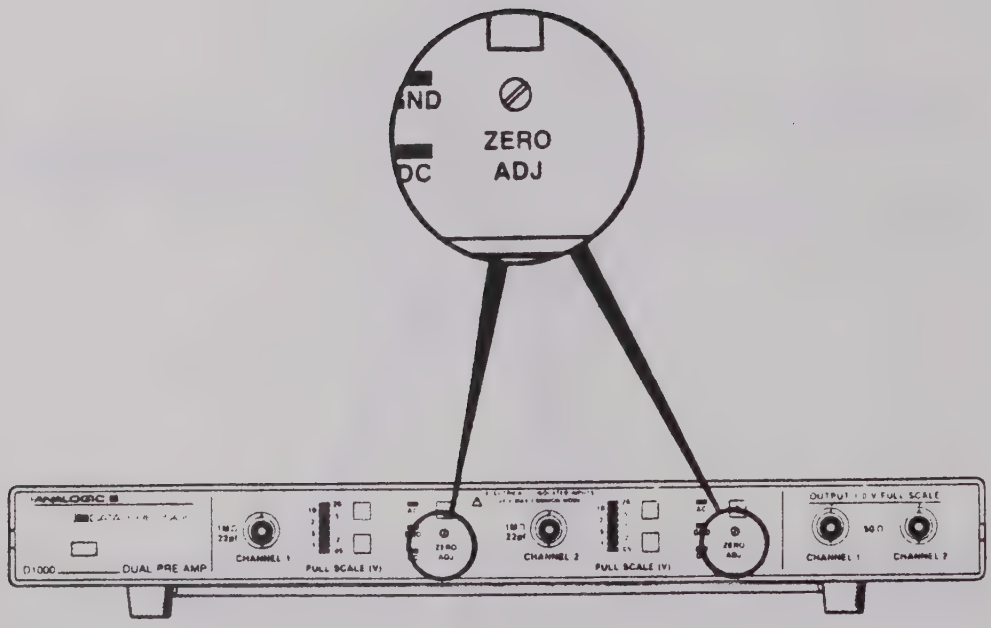



FIGURE 3-5. D1000 DUAL PRE-AMP, ZERO ADJ CONTROL

## 3.3 HOW TO USE THE D1000 TO MEASURE VOLTAGES

To use the D1000 to measure voltages initially after you have installed the DUAL PRE-AMP, perform steps 1 thru 6 that follow. After that time, select the steps necessary to measure the desired voltage.

1. Connect coaxial cables between the D1000 and the 50-Ohm terminator box on the MODEL 620 Plug-in Module of the D6000.

2. Connect coaxial cables between the D1000 and the voltage source.

3. Turn on the D1000.

4. Select the desired coupling.

5. Select the desired FULL SCALE voltage range for the input signal.

6. Use the ZERO ADJ to correct any d-c offset as required. (If the Ext. Control Option has been installed in your D1000, this option corrects d-c offset automatically.

7. Read the voltage value on the screen of the D6000 corresponding to the input you are measuring.

8. Calculate the value of the source voltage using the following formula:

$$V_{IN} = (FS)(V_r)$$

where:

$V_{IN}$ = the value of the source voltage in volts

FS = the value in volts of FULL SCALE range on the D1000

$V_r$ = The reading in volts of the voltage value on the screen of the D6000 corresponding to the source voltage.

NOTE

If the Ext. Control Option has been installed in your D1000, you do not have to use the formula. The option displays the correct value directly on the D6000.

Each of these steps is described in detail in paragraphs 3.3.1 through 3.3.6 that follow. Use these paragraphs to help you use the D1000 to measure a voltage.

### 3.3.1 Connecting Input and Output Cables to the D1000 DUAL PRE-AMP.

1. Referring to Figure 3-6, connect the output cable, to which the 50-ohm terminator box has been attached, between CHANNEL 1 on the MODEL 620 and CHANNEL 1 OUTPUT on the D1000.

2. Connect the input cable between CHANNEL 1 input on the D1000 and the voltage source.

3. If you want to use CHANNEL 2, of the D1000, connect the second pair of cables the same way.

NOTE

You can connect cables to either or both channels.

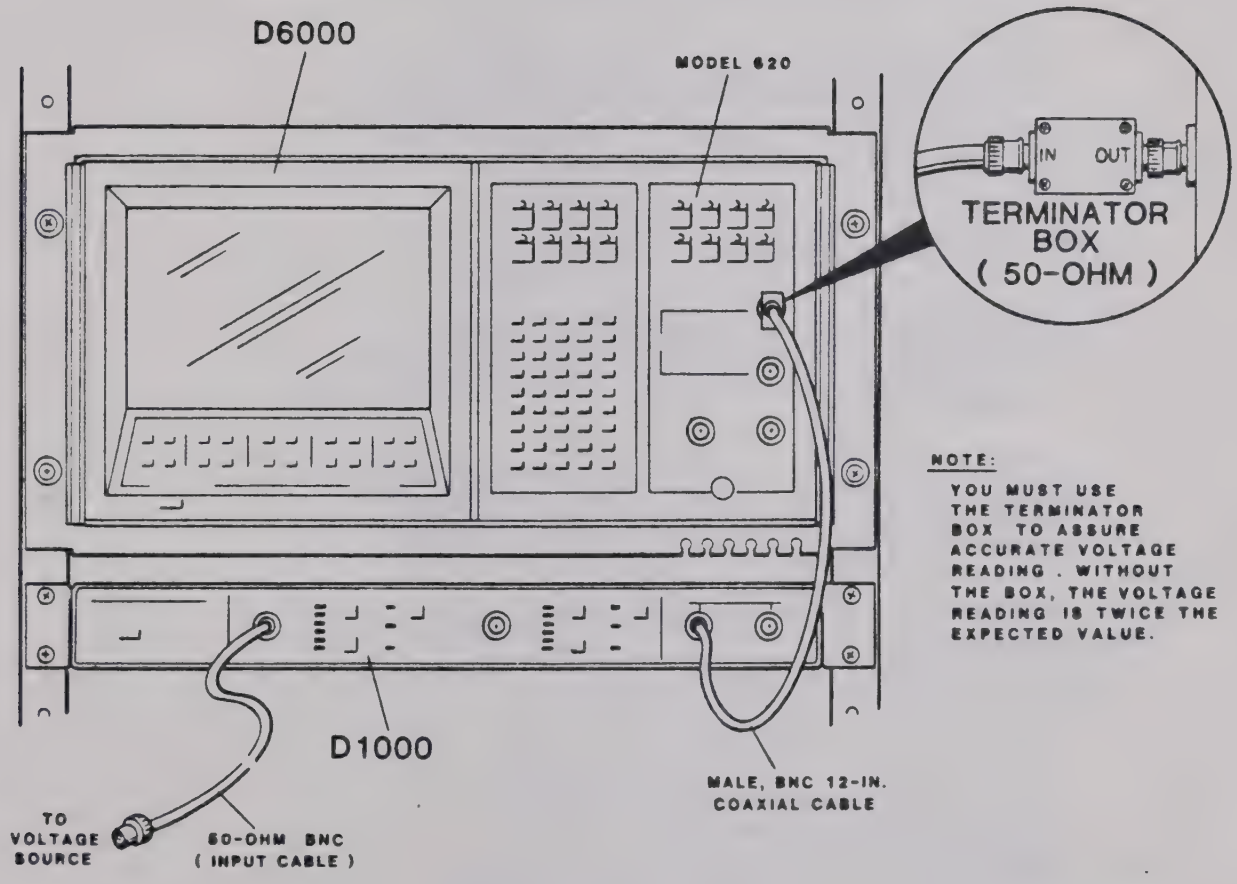

D6000
MODEL 620
IN
OUT
TERMINATOR BOX ( 50-OHM )
NOTE:
YOU MUST USE THE TERMINATOR BOX TO ASSURE ACCURATE VOLTAGE READING . WITHOUT THE BOX, THE VOLTAGE READING IS TWICE THE EXPECTED VALUE.
D1000
MALE, BNC 12-IN. COAXIAL CABLE
TO VOLTAGE SOURCE
50-OHM BNC ( INPUT CABLE )

FIGURE 3-6. D1000 DUAL PRE-AMP, CABLING DIAGRAM FOR INPUT AND OUTPUT CABLES

### 3.3.2 Turning on the D1000 -

1. Set the ON - NOT ON switch to ON.

2. Notice that the "20" and the "DC" indicators for both CHANNEL 1 and 2 turn on. This shows that the D1000 is on and ready for operation.

### 3.3.3 Selecting the Desired Coupling -

1. The D1000 is DC coupled to the voltage source when the D1000 is first turned on.

2. If you desire AC coupling, press the pushbutton until the AC indicator is on. The voltage source is now a-c coupled to the DUAL PRE-AMP (the DC indicator will turn off).

### 3.3.4 Selecting the Desired FULL SCALE Range -

1. The D1000 is set to receive an input voltage of +/- 20V when the DUAL PRE-AMP first turned on. This is the highest voltage scale.

2. To select a lower scale, press the lower black pushbutton. Each time you press this button, you select the next lower scale (20V to 10V, 10V to 5V, etc.).

The lighted indicator shows which range you have selected.

NOTE

When you reach the lowest scale, .05V, further pressing of the lower pushbutton has no effect on the D1000. You have reached the lowest value. Press the upper pushbutton to move up scale.

3. To select a higher range, press the upper black pushbutton. Each time you press the pushbutton, you select the next higher range (.05V to .1V, .1V to .2V, etc.). Again, the lighted indicator shows you which scale you have selected.

NOTE

When you reach the highest scale, 20V, further pressing of the upper button has no effect on the D1000. Press the lower pushbutton to move down scale.

### 3.3.5 Correcting D-C Offset Voltages -

1. Set the coupling to GND by pressing the pushbutton until the GND indicator is on. This disconnects the voltage source from the input to the DUAL PRE-AMP and switches ground to the input.

2. Using a small screwdriver, rotate the ZERO ADJ for a zero reading on the D6000.

NOTE

Each time you select a new range you may have to adjust for zero d-c offset with the ZERO ADJ control.

3. If the Ext. Control Option is installed in your D1000, the D6000 automatically corrects the d-c offset voltage with its "auto-zeroed" feature.

### 3.3.6 Measuring the Value of Your Voltage Source -

1. Read the voltage value on the screen of the D6000 corresponding to the input voltage.

2. Read the value of the FULL SCALE on the D1000 you are currently using.

3. Use the following formula to calculate the value of the source voltage:

$$V_{IN} = (FS)(V_r)$$

4. If the Ext. Control Option is installed in your D1000, you can read the voltage directly on the D6000. You do not have to use the formula shown in step 3. The option automatically corrects for full scale value.

## 3.4 HOW TO CHANGE VOLTAGE SOURCES DURING OPERATION

1. Set the coupling to DC.
2. Select the desired FULL SCALE (V) range. If not known, select 20V.
3. Remove the source input cable (the cable connected to CHANNEL 1 or 2 input) from the voltage source.
4. Replace the old voltage source with the new source.
5. Reconnect the input cable to the new voltage source.

## 3.5 HOW TO SHUT DOWN D1000

1. Press the ON-NOT-ON pushbutton to NOT ON position. Notice that both the FULL SCALE (V) indicator and the lighted coupling indicator (AC or GND or DC) for both CHANNEL 1 and 2 go out. This shows that power has been removed from the D1000.

NOTE

Perform steps 2 and 3 that follow at your discretion.

2. Remove the output cable from the CHANNEL 1 or 2, OUTPUT 1.0V FULL SCALE connector.

3. Remove the input cable from the CHANNEL 1 or 2 connector.

SECTION 4

# PRINCIPLES OF OPERATION

## 4.1 INTRODUCTION

This Section describes the principles of operation of the D1000 DUAL PRE-AMP. It covers the following topics:

- o Overview of Operation
- o Detailed Description of Operation
  - How D1000 Selects Full Scale Range
  - How D1000 Selects Coupling Method
  - How D1000 Conditions Source Voltages for Measurement

It provides you with enough information to have a broad understanding of how the D1000 works. This will help you use the instrument properly, and will help you recognize a malfunction should one occur.

## 4.2 PRINCIPLES OF OPERATION

### 4.2.1 Overview of Operation

The primary purpose of the D1000 is to extend the voltage measurement range of the MODEL 620 Plug-in Module for the D6000. The D1000 extends the full scale range of the source voltage from 0.05V to 20V in nine steps as follows:

.05V
.1V
.2V
.5V
1.V
2.V
5.V
10.V
20.V

The secondary purpose of the D1000 is to function as a standalone, pre-amplifier that can be used with any measuring devices -- not just the D6000.

To help you understand how the D1000 DUAL PRE-AMP functions, refer to Figure 4-1, which is an overall block diagram of the pre-amplifier. This Figure shows you the major printed circuit boards (PCB) within the D1000 and how they are connected electrically. The thick lines on Figure 4-1 show you the signal flow through the D1000.

Notice that the D1000 consists of a control panel, two amplifiers (one for CHANNEL 1 and one for CHANNEL 2), a panel control PCB, and a power supply.

The control panel contains all the switches and indicators for selecting and displaying both the full scale range and the coupling method.

Each amplifier (for CHANNEL 1 and CHANNEL 2) provides the proper signal conditioning for the selected full scale range. (The amplifier is sometimes referred to as the analog PCB.)

The panel control PCB works in conjunction with the control panel and the amplifiers. It receives signals from pushbuttons on the control panel that instruct the PCB to select either a particular full scale range or coupling method.

The PCB responds by instructing the CHANNEL 1 or CHANNEL 2 amplifier to set up the proper circuit configuration for the desired full scale range or coupling method. In addition, the PCB sends a signal to the control panel that turns on the proper indicator for the selected range or coupling method.

The power supply provides the operating voltages for the control panel, amplifiers, and the panel control PCB. The D1000 can be powered from either a 115 VAC or 230 VAC source depending upon how you set a LINE VOLTAGE SELECTOR switch on the back of the DUAL PRE-AMP.

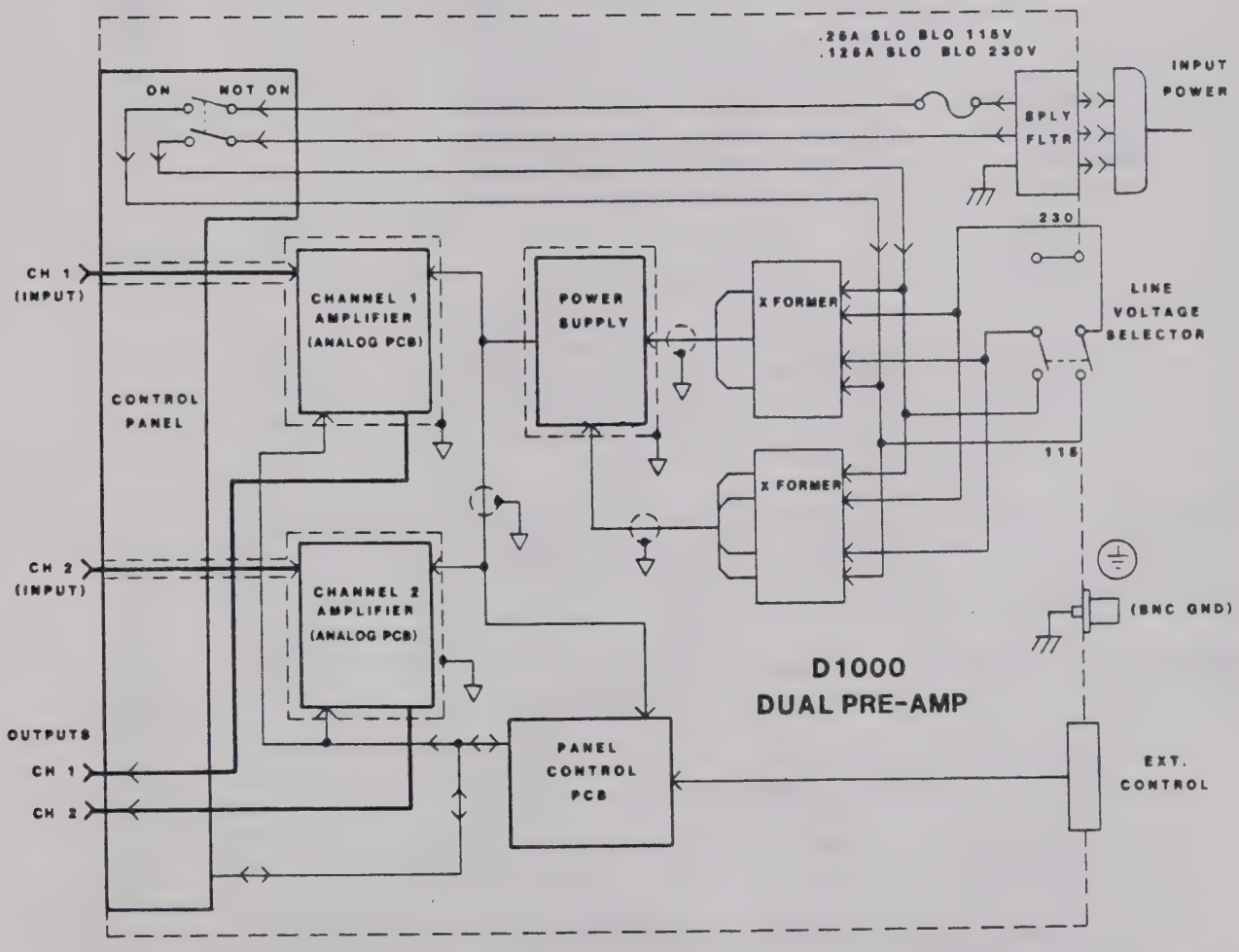



FIGURE 4-1. OVERALL BLOCK DIAGRAM

The EXT. CONTROL, shown on Figure 4-1 allows you to connect an optional cable between the D6000 and the D1000. This cable, plus the replacement PROM set which is plugged into the 620 Plug-in Module, allows you to select the desired full scale range and coupling method from the keyboard of the D6000.

### 4.2.2 Detailed Description of Operation -

Figure 4-2 is a functional block diagram for the D1000. It shows the CHANNEL 1 amplifier, the control panel, and the panel control PCB. This diagram will help you better understand the operation of the D1000, and it will help you locate a circuit malfunction, should one occur.

The Figure shows the major components within the amplifier, the control panel, and panel control PCB. A ribbon cable interconnects the amplifier, control panel, and panel control PCB. This cable is shown as a single line. The number associated with each line tells you the number of wires in that cable.

Study the figure for a few minutes. It shows you the circuit configuration for the three basic operations the D1000 performs. (CHANNEL 2 functions the same way.)

Basically, the D1000 performs three operations for the measurement of voltages.

- It selects the desired FULL SCALE (V) range for voltage measurement.
- It selects the desired coupling method.
- It conditions the source voltage to be measured.

**4.2.2.1 How D1000 Selects FULL SCALE (V) Range -** Locate the "up" and "down" switches plus the .05 thru 20 indicator lamps on the control panel of Figure 4-2.

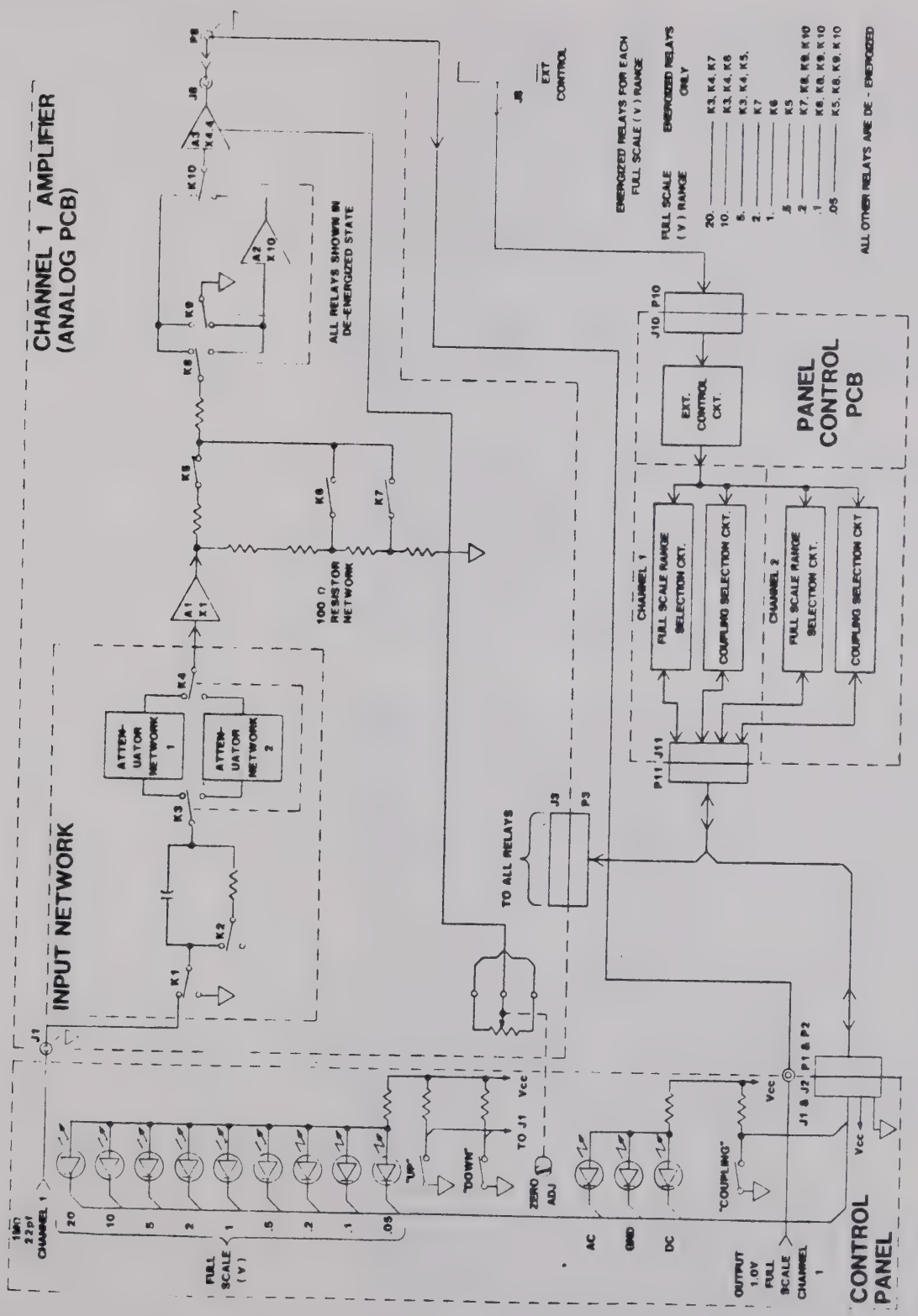



FIGURE 4-2. FUNCTIONAL BLOCK DIAGRAM

Also locate a full scale range selection circuit for CHANNEL 1 within the panel control PCB, and relays K3 thru K10 on the amplifier. This circuit configures the D1000 for the full scale voltage measuring ranges of +/- 0.05V to +/- 20V.

Each time you press either the "up" or "down" pushbutton, you apply OV (ground) to the full scale range selection circuit within the panel control PCB. This circuit then generates an output that both energizes the proper relays within the amplifier and turns on the appropriate indicator.

The full scale range selection circuit works very much like a rotary selector switch. It generates an output that selects only one full scale range at a time. Each time you press the "up" pushbutton, you cause this circuit to select the next higher range. Conversely, each time you press the "down" pushbutton, you cause it to select the next lower range.

Recall that when you first apply power to the D1000, the 20V indicator turns on. The full scale range selection circuit is designed to do this. When power is initially applied to this circuit; it generates an output that both turns on the 20V indicator and energizes relays that configure the amplifier to receive this voltage.

To change the FULL SCALE (V) range, you must press and release the appropriate "up" or "down" pushbutton. If you should press the pushbutton and not release it, you will cause the range to move to the next position and remain in that position. It will not advance any further.

**4.2.2.2 How the D1000 Selects Coupling Method** - Refer to Figure 4-2. Locate the "coupling" pushbutton, the AC, GND, and DC indicator lamps on the control panel; locate relays K1 and K2 on the

Channel 1 amplifier; and locate the coupling selection circuit within the panel control PCB. These circuit elements allow you to select the desired coupling for your voltage measurement.

The coupling selection circuit acts like a rotary selector switch that rotates in one direction only. It generates outputs that select one coupling method at a time. Each time you press the "coupling" pushbutton, the circuit selects the next sequential coupling method. The sequence is DC to GND to AC, which then repeats continuously. The coupling selection circuit is designed to function this way.

Also recall that when the D1000 is first turned on, the DC indicator turns on. Again the coupling selection circuit is designed to do this. When power is initially applied to this circuit, it generates outputs that both turn on the DC indicator and configure the amplifier for d-c coupling.

**4.2.2.3 How the D1000 Conditions Source Voltages for Measurement -** Refer to Figure 4-2 and locate the CHANNEL 1 amplifier circuit. This is the circuit that conditions the source voltage to be measured. (CHANNEL 2 is identical to CHANNEL 1.)

This circuit is designed to assure you valid voltage measurements of complex waveforms. It features a bandwidth of 0 - 35MHz. Moreover, it is designed for low distortion. It also features a high input impedance of 1 Megohm, which is in parallel with a capacitance of 22 pf. The output impedance is low: 50 ohms. The inputs and outputs are floating with respect to ground.

It is important to realize that the output voltage appearing at the output connector is a non-inverted, faithful representation of the source voltage appearing at the input connector. The nominal, full scale value of the output

voltage is +/-1V (+/-1.2V max.), regardless of the full scale value of the source voltage.

The CHANNEL 1 and CHANNEL 2 amplifiers together provide two, independent channels. This allows you to measure two voltage sources independently without interaction between them.

From Figure 4-2, notice that the CHANNEL 1 (and CHANNEL 2) amplifier consists of an input network, three amplifiers, a voltage divider network, and relays. The relays, when energized in the proper order, select both the correct circuit configuration for each of the nine FULL SCALE (V) ranges and the desired coupling: K3 - K10 for the FULL SCALE (V) ranges, and K1 and K2 for coupling.

Study this circuit to see how the source signal flows from the input to the output. Also examine the table on Figure 4-2 to see how the relays configure the various circuit elements for each FULL SCALE (V) range setting.

Basically the amplifier conditions the source voltage by applying the proper gain to achieve the desired output of +/- 1.0V. Table 4-1 lists the voltage gain for each of the FULL SCALE (V) input ranges.

TABLE 4-1. VOLTAGE GAIN FOR EACH FULL SCALE (V) RANGE SETTING

| FULL SCALE Input (in +/- V) | Voltage Gain | Full Scale Output (in +/- V) |
|---|---|---|
| .05 | 20. | 1.0 |
| .1 | 10. | 1.0 |
| .2 | 5. | 1.0 |
| .5 | 2. | 1.0 |
| 1.0 | 1. | 1.0 |
| 2.0 | .5 | 1.0 |
| 5.0 | .2 | 1.0 |
| 10.0 | .1 | 1.0 |
| 20.0 | .05 | 1.0 |

The nominal, full scale output of the D1000 is +/- 1V. However, the actual full scale output is +/- 1.2V. This provides you with sufficient "head room" to assure you that the source voltage you are trying to measure will not be clipped by the D6000. This also means that you can apply a source voltage range that is 20 percent greater than the FULL SCALE (V) range you are currently using.

SECTION 5

MAINTENANCE

## 5.1 INTRODUCTION

This Section provides instructions for maintaining the D1000 DUAL PRE-AMP. It presents the following topics:

- Fuse replacement
- How to determine if your D1000 is malfunctioning
- Corrective action
- Calibration procedures

Basically the maintenance procedures for your D1000 are simple. You can change a blown fuse, but you must return a malfunctioning DUAL PRE-AMP to the factory for repair. When your D1000 requires re-calibration, you can return it to the factory, send it to a qualified calibration laboratory, or re-calibrate it yourself.

## 5.2 FUSE REPLACEMENT

If you notice that both the 20V and DC indicators for both channels are out, check the fuse on the back of the D1000. Referring to Figure 5-1, do the following:

1. Remove the power cable from the connector for the cable.
2. Remove the blown fuse.
3. Replace with a fuse having the same specified voltage and current rating.
4. If the fuse blows again, follow the procedures listed in paragraph 5.4.

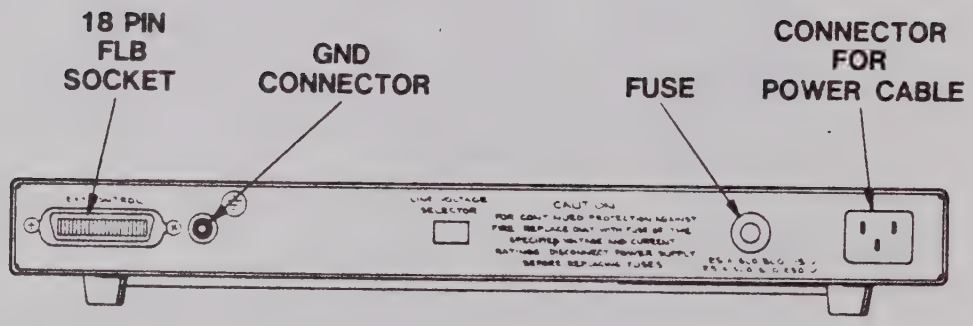



FIGURE 5-1. REAR VIEW OF D1000

## 5.3 HOW TO DETERMINE IF YOUR D1000 IS MALFUNCTIONING

Your D1000 is very reliable. There should be very few times when it malfunctions. There are, however, a few symptoms to look for that might indicate a possible trouble.

1. One or more FULL SCALE (V) indicators may not turn on, when selected by the pushbutton.

2. One or more of the "coupling" indicators (DC, GND, AC) may not turn on, when selected by the pushbutton.

3. Repeated pressing of the appropriate pushbutton does not select either another FULL SCALE (V) range or another coupling method.

4. When a particular FULL SCALE (V) indicator is on, there is no signal output for that indicated range.

5. There may be no signal output for certain FULL SCALE (V) ranges even though the indicators for these ranges are on. These ranges are:

   20V, 10V, 5V

   2V, 1V, .5V

   .2V, .1V, .05V.

If you have these or another trouble symptom, use Figures 4-1 and 4-2 to help you decide if you have a malfunction.

## 5.4 CORRECTIVE ACTION

If your D1000 malfunctions, do not attempt to repair it. Do the following:

1. If you reside within the continental USA outside the 617 Area Code, call the toll-free number,

   1-800-237-2200

If you reside within the 617 Area Code, call

246-0300, Ext. 2255

Make all calls between the hours of 8:30 AM and 5:00 PM EST/EDT.

2. Describe your problem to the customer service representative answering the call.

3. The customer service representative will advise you how your D1000 will be serviced.

APPENDIX A

EXTERNAL CONTROL OPTION

## A.1 GENERAL DESCRIPTION

You may purchase an option from Data Precision that allows you to select the FULL SCALE (V) voltage measuring range and the coupling method from the D6000/620. This option includes a cable and PROM's. The cable connects the EXT. CONTROL connector on the back of the D6000 with the EXT. CONTROL connector on the back of the D1000. The PROM's, which are plugged into the MODEL 620 Plug-in Module, provide the firmware to make the option work.

## A.2 WHAT OPTION DOES

With this option, the D6000 provides address and data signals to the D1000 that perform three major functions.

- Enables or disables the control panel of the D1000.
- Selects the full scale range selection circuit for each channel.
- Selects the coupling selection circuit for each channel.

When the D1000 control panel is disabled, you can select both the value of the full scale range and the coupling method remotely from the D6000. The pushbuttons on the control panel of the D1000 are disabled, but the indicator lights still display the current FULL SCALE (V) range value and the coupling method. When the D1000 control panel is enabled, you can use the pushbuttons on the control panel to perform these functions locally.

Once you have installed the option, you will use certain keys on the control panel of the D6000 the same way you use the pushbuttons on the control panel of the D1000. There will be both an "up" key and a "down" key that selects respectively the next higher or lower full scale range value. Also there will be a "coupling" key that selects the desired coupling method.

The installation instructions provided with the option will tell you which keys to use.

## A.3 INPUT SIGNALS AT EXT. CONTROL CONNECTOR

Refer to Figure A-1. This figure is a simplified functional block diagram that shows you the signal flow through the EXT. CONTROL CIRCUIT to the other circuit elements on the panel control PCB. It also shows the signals present at the EXT. CONTROL connector. Study this figure for a few minutes to become familiar with its details.

Refer to Figure A-2. This figure shows the timing relationship between the ADDRESS WRITE (*ADRWR), the DATA WRITE (*DATAWR) strobe signals; and the data signals ($D_0$ - $D_3$). Study this figure to become familiar with its details.

Whenever you want to set a new range value or coupling method, you must:

1. Set an address with *ADRWR
2. Select the value (or data) with *DATAWR.

Each of the strobe signals must have a minimum pulse width of 200 usec. The data signals must have the following characteristics: The minimum set-up time (TS) is 100 nsec, the minimum hold time (TH) is 50 nsec.

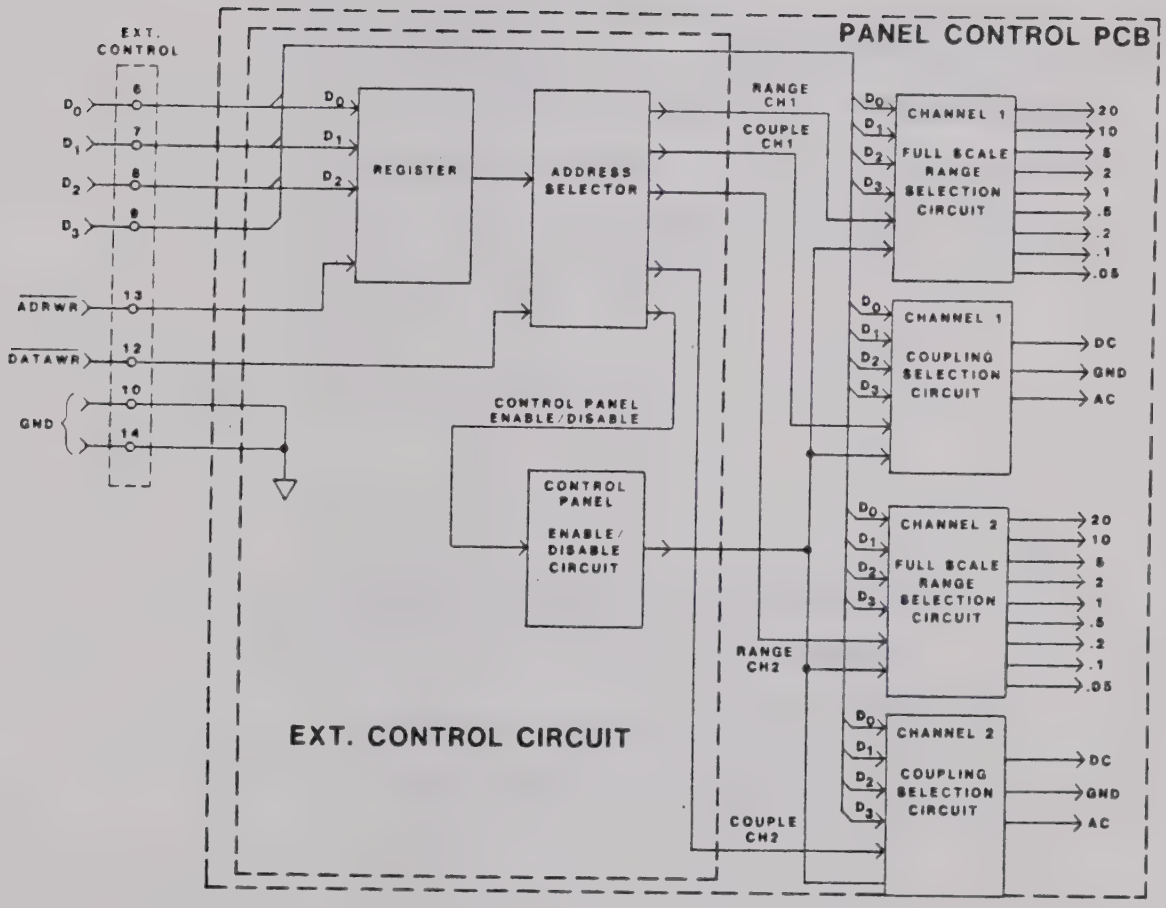
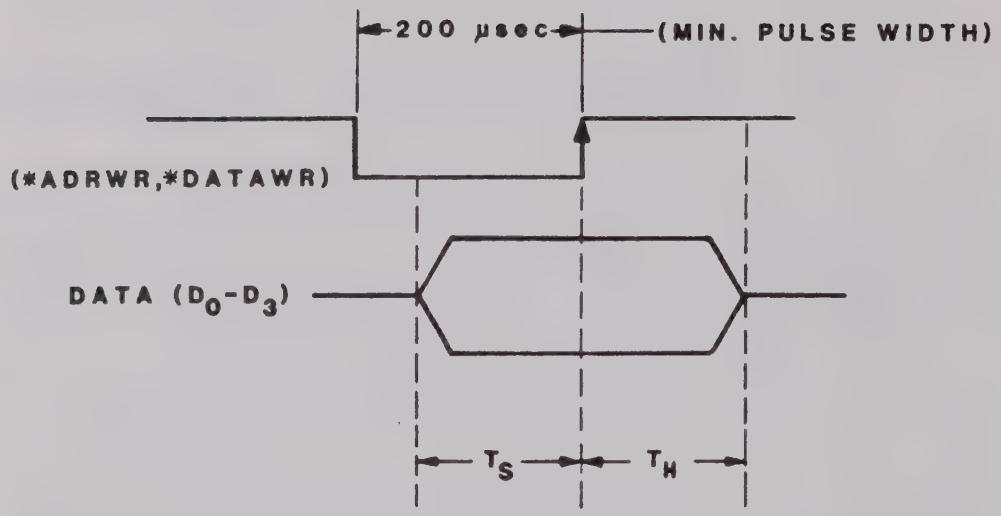



FIGURE A-1.. SIMPLIFIED FUNCTIONAL BLOCK DIAGRAM OF EXT. CONTROL CIRCUIT




**SUMMARY OF MINIMUM PULSE WIDTHS**

*ADRWR,*DATAWR: 200 µsec (for each)

DATA ($D_0$-$D_3$)

$T_S$(SET-UP TIME): 100 nsec

$T_H$(HOLD TIME): 50 nsec

FIGURE A-2. TIMING DIAGRAM FOR ADDRESS AND DATA SIGNALS AT EXT. CONTROL CONNECTOR

The strobe signals must be active before the data signals. The timing between the *ADRWR and the *DATAWR is not critical. Table A-1 shows the data value (in hex.) for each address whenever *ADRWR is active. Table A-2 shows the data value (also in hex.) for each address function whenever *DATAWR is active.

The proper sequence for sending signals to the D1000 is as follows:

1. Disable the control panel of the D1000.
2. Select the desired address: RANGE CH1, RANGE CH2, etc..
3. Select desired range value or coupling method.

TABLE A-1. DATA VALUES FOR ADDRESS (*ADRWR ACTIVE)

| Address | D0, D1, D2 (Hex. Value) |
|---|---|
| RANGE CH1 | 0 |
| COUPLE CH1 | 1 |
| RANGE CH2 | 2 |
| COUPLE CH2 | 3 |
| CONTROL PANEL | 4 |

TABLE A-2. DATA VALUES FOR ADDRESS FUNCTION (*DATAWR ACTIVE)

| Function | D0, D1, D2, D3 (Hex. Value) |
|---|---|
| RANGE | |
| 20.V | 0 |
| 10.V | 1 |
| 5.V | 2 |
| 2.V | 3 |
| 1.V | 4 |
| .5V | 5 |
| .2V | 6 |
| .1V | 7 |
| .05V | 8 |
| COUPLE | |
| DC | 0 |
| GND | 1 |
| AC | 2 |
| CONTROL PANEL | |
| enabled (local) | 1 |
| disabled (remote) | 0 |

APPENDIX B

# SHORTING FLOATING GROUND TO CHASSIS GROUND OF D1000

## B.1 INTRODUCTION

Shorting of floating ground to chassis (earth) ground of the D1000 is an option that you decide either to do or not to do. You must base your decision on whether or not your voltage measurements, particularly on the lower ranges of .5V, .2V, .1V, and .05V, are too noisy to produce accurate measurements. If you decide that they are too noisy, perform the steps in para. B.2 that follows.

## B.2 SHORTING INSTRUCTIONS

1. If the D1000 is mounted in a rack, remove it from that rack as follows:

   a. Turn off the power to the DUAL PRE-AMP.

   b. Remove all cables.

   c. Remove the mounting hardware (see Figure B-1).

   d. Slide the D1000 out of the rack (see Figure B-1).

2. Remove the screws holding the top cover to the main chassis of the D1000 (see Figure B-2).

3. Carefully lift the top cover off the chassis (see Figure B-2).

4. Find the press-on tabs on the output cables (see Figure B-3).

5. Cut the cable tie wrap (see Figure B-3).

6. Remove cable connector (see Figure B-3).

7. Press each tab onto the ground lugs E14 and E15 located on the CHANNEL 2 amplifier board (see Figure B-4). It does not matter which ground lug you use.

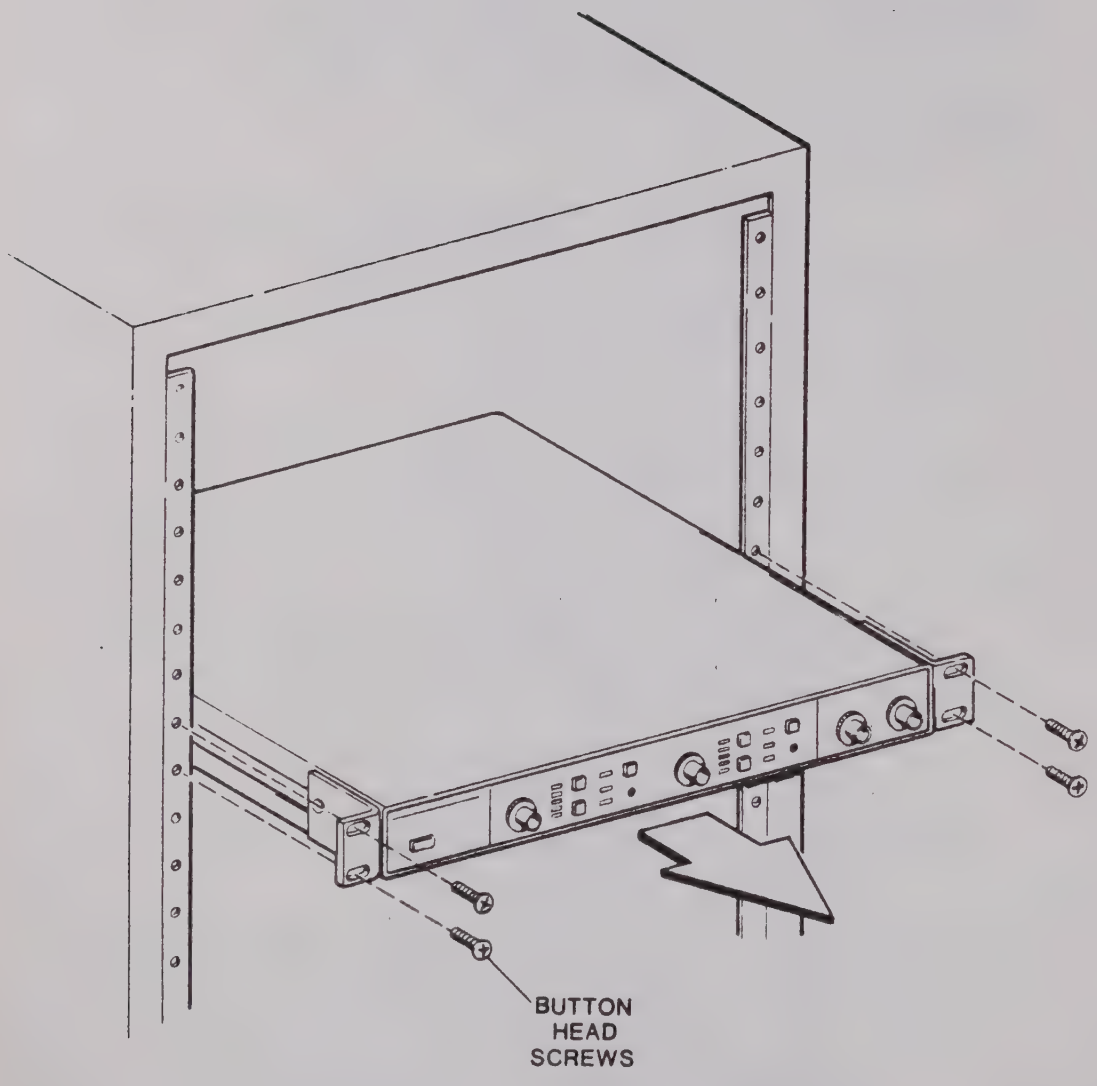



FIGURE B-1. REMOVING D1000 FROM 19-INCH RACK

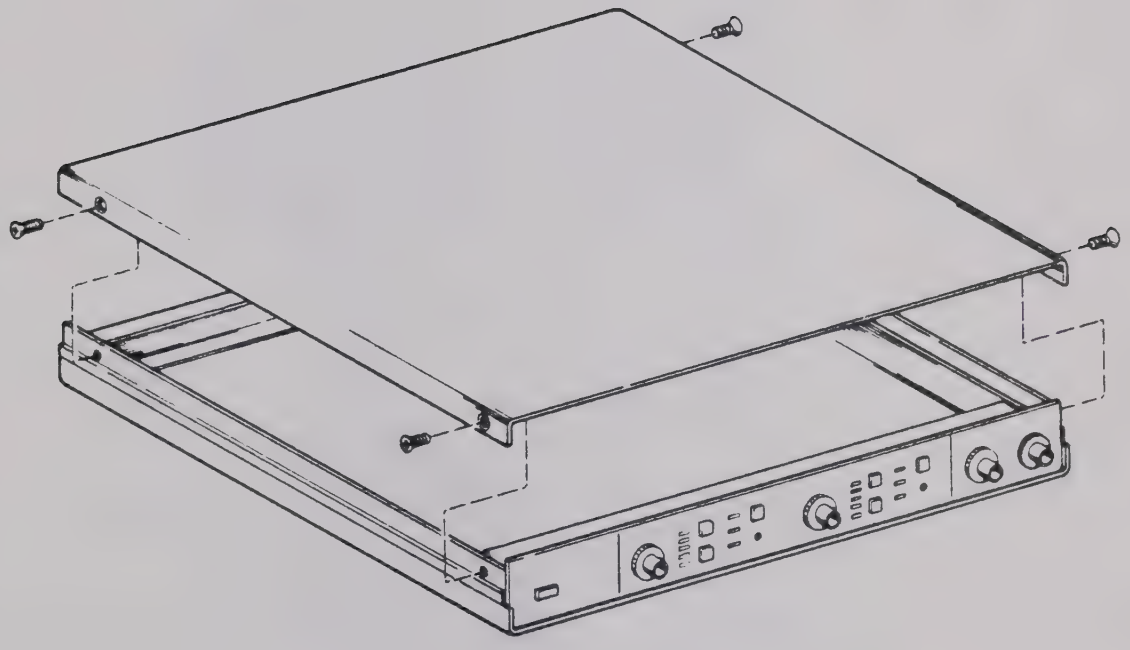


FIGURE B-2. DISASSEMBLY OF TOP COVER FROM D1000

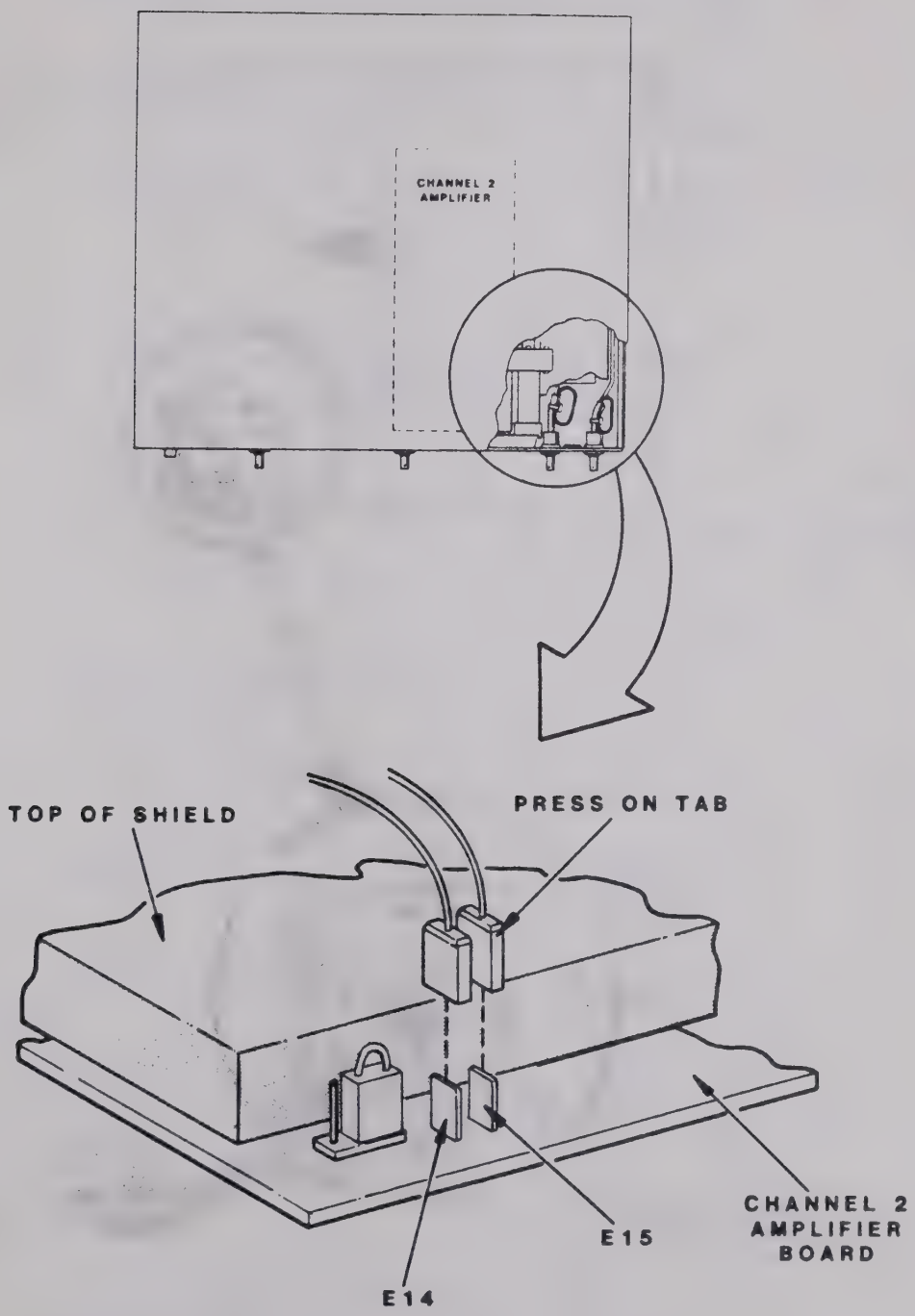



FIGURE B-4. PUSHING PRESS-ON TABS ON OUTPUT CABLES ON TO GROUNDING LUGS E14 AND E15

8. Locate a moveable shunt located on the CHANNEL 2 amplifier board (see Figure B-5).

9. Move this shunt from the "A" side of the connector the "B" side (see Figure B-5).

10. Repeat steps 8. and 9. for the CHANNEL 1 amplifier board.

NOTE

You have now shorted the floating ground of each CHANNEL 1 and CHANNEL 2 amplifier to chassis ground.

## B.3 REASSEMBLY INSTRUCTIONS

1. To reassemble your D1000, proceed as follows:

   a. Check all your electrical connections to be sure they are firmly in place.

   b. Carefully place the top cover onto the main chassis.

   c. Fasten the cover to the main chassis with the screws removed in step 2., para. B.2.

2. Select step a. or b. that follow as appropriate.

   a. If you removed your D1000 from a rack, go to para. 2.3.1 in Section 2 of this manual. Use the procedures listed in that section to help you reinstall the DUAL PRE-AMP into the rack.

   b. If your D1000 was employed in a standalone configuration, go to para. 2.3.2 in Section 2 of this manual. Use the procedures listed in that section to help you reinstall your D1000.

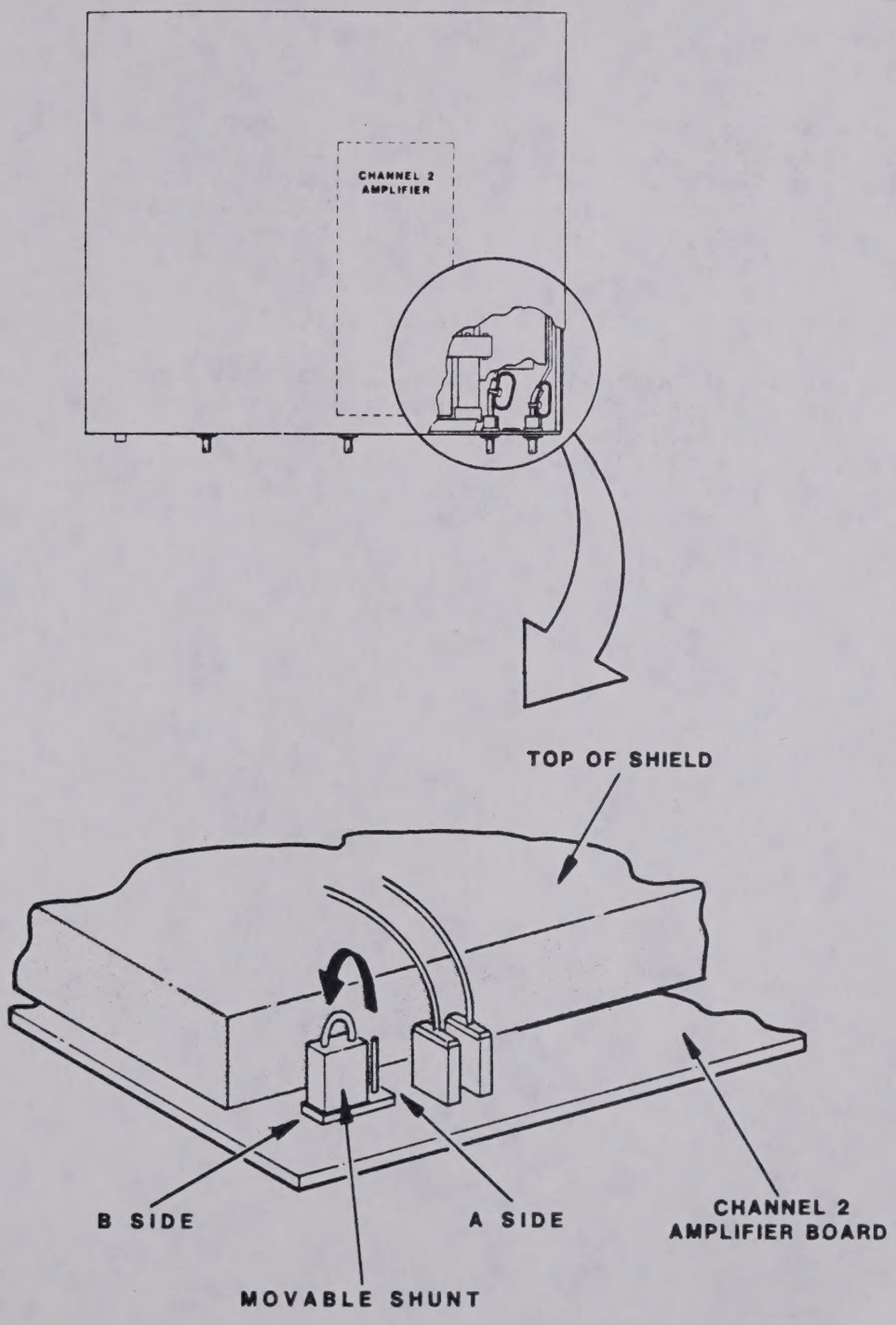



FIGURE B-5. TRANSFERRING MOVEABLE SHUNT FROM A SIDE TO B SIDE

## B.4 DESIGNATE THAT INPUTS AND OUTPUTS ARE NO LONGER FLOATING

Once you have grounded the inputs and outputs of the D1000, they are, of course, no longer floating. You should then designate somewhere on the front panel of the D1000 that the inputs and outputs are no longer floating. How you do this is left up to you.

## B.5 RESTORING FLOATING INPUT AND OUTPUT FEATURE

If you decide at some time in the future that you want to restore the floating input and output feature of the D1000, you must disconnect the ground connections you made in steps 1 thru 9, para.B.2. To restore the floating input and output feature, follow these procedures in reverse order.

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